IRcCOS S.c.a r.l.

Istituto di Ricerca e certificazione per le Costruzioni Sostenibili
Test Laboratory Notified in accordance with Regulation (EU) No 305/2011

TEST REPORT

Number:
1994-CPR-RP1303

Issuing date:
2016-02-08

Applicant:
GLASSCON GmbH
Südliche Münchner Straße 2
82031 Grünwald/München (Germany)

Tested product:
"GLASSCON CUSTOM MADE PUNCH WINDOW, SNFCC - RENZO PIANO FT-03 FAÇADE SYSTEM"
(cf. description)

Executed tests:
Air permeability
Watertightness under static pressure
Resistance to wind load

Normative References:
EN 13830:2003
EN 12153:2000 · EN 12152:2002
EN 1026:2000 · EN 12207:1999
EN 12155:2000 · EN 12154:1999
EN 12179:2000 · EN 13116:2001

The report is done up of 59 pages, including any annex, and can be reproduced only integrally

3 Description of the tested sample

The sample under test is a custom made punch window ''GLASSCON/ SNFCC – RENZO PIANO FT-03 FAÇADE SYSTEM'', with trade name given by the applicant "GLASSCON GmbH".
The sample was identified by the applicant in accordance with product standard EN 13830:2003.
The identification code of the tested sample, as declared by the applicant, is: "GLASSCON/ SNFCC – RENZO PIANO FT-03 FAÇADE SYSTEM''.
Both description and technical drawings below, referred to the tested sample, were declared and supplied by the applicant under his own responsibility.

- Material: aluminium EN AW 6060 T66 (EN 573-3, EN 12020.2).

- Profiles (cf. Figures):
  - frame (27a+27b), code 29685,
  - sash (34) code 29686,
  - mullion (60) code 29681,
  - cover profile (26) code 34374,
  - cover profile (57) code 34375,
  - supplementary profile, SG anodized (38) code 34373.

  all produced by ETEM Bulgaria S.A. 119A Ilientzi BLVD, Sofia, Bulgaria;
  - "L" profile 40x15x4mm,

  produced for SNFCC project.

- Joint corner brackets (cf. Figures):
  - joint corner bracket for 29685 (46),
  - joint corner bracket for 29685 (45),
  - joint corner bracket for 29686 (47),
  - joint corner bracket for 29686 (48),
  - joint corner bracket for 29686 (49)

  all made of extruded aluminium EN AW 6060 T66 (EN 573-3, EN 12020.2) and produced for SNFCC project.

- Alignment (cf. Figures):
  - alignment square for 29685 (44),

  made of extruded aluminium. EN AW 6060 T66 (EN 573-3, EN 12020.2) and produced for SNFCC project.

- Glazing:
  - double glazing made of extra clear float glass (6mm+6mm glass-16mm -6mm+6mm glass) produced by Glasscon, Athens, Hellas, with secondary seal IG 25 Supplied by SIKA Hellas, Athens.

- Insulation material:
  - polyamide bar 10mm, code 244800 for 29686
  - polyamide bar 22mm, code 245800 for 29686 & 29685
  - polyamide bar 14mm, code 948600 for 29685
  - polyamide bar 26mm, code 978800 for 29685

  all made of polyamide reinforced with 25% glass fibers and produced by Technoform Bautec GmbH, Fuldaruck, Germany.

- Glazing gaskets (cf. Figures):
  - internal: spacer for glazing in silicone (32),
  - spacer for glazing in silicone (mullion side) (61),

  silicone Produced for SNFCC project
  both produced for SNFCC project.

Sealing gaskets (cf. Figures):	- internal seal gasket for 29685 inEPDM (31), - seal gasket for 29685 & 29681 in EPDM (28), - seal for joint between wall-façade in EPDM (33) - external seal gasket for mullion in EPDM (51), all produced for SNFCC project.
Accessories (cf. Figures):	- self adhesive/expanding tape 8/25 (24), - al-butyl tape (105), - single side adhesive tape (10x2mm) (18), all in material: PU, Romyband 300-BG2 end produced for ROMKA, Hellas; - backer rod (41), in material: Polyethylene and produced by ESHA ALPHA ENERGY S.A, Athens, Hellas; - structural silicone (S.G -500CN) (39), - weather silicone (SIKASIL WS-605 S) (40), both supplied by SIKA Hellas, Athens, Hellas; - spacer(7x15mm) (52), - special part (22), - spacer (16), - custom part (37), - spacer (21), all in material: aluminium EN AW 6060 and produced for SNFCC project; - insert (for mullion) (64), - corner for glazing support(25x30x2mm) anodized, length:100mm or 150mm (42), - spacer (80x6mm) length:150mm (65), - spacer length:150mm (66), - spacer length:150mm (45x4mm) (67) all in material: Aluminium, EN AW 6060 T66 (EN 573-3, EN 12020.2) and produced by ETEM Bulgaria S.A., Sofia, Bulgaria; - hexagon bolt M8x50-8.8 (23-1), - washer for hexagon bolt M8 (23-2), - hexagon bolt M6x10-8.8 (36), - hexagon socket head cap screw M10x65 8.8 (12-1), - hexagon socket head cap screw M8x30 8.8 (104), - pan head tapping screw ST4.8x32mm (107), - countersunk head tapping screw ST4.8x19mm (106), - countersunk head tapping screw ST4.8x22mm (35), all in material: Galvanised Steel and supplied by DAMIGOS S.A, Piraeus, Hellas; - nipple screw 4x10 (5), in material: Galvanised steel and supplied by Wuth Hellas, Hellas.
Declared nominal dimensions:	- width of frame: 2420mm, - width of sash A: 1208.5mm, - width of sash B: 1150.5mm, - height of frame: 2920mm, - height of sash(A&B): 2874mm, total dimensions of sample (including frame wall joining gasket 33): - width: 2516mm, - height: 3016mm.

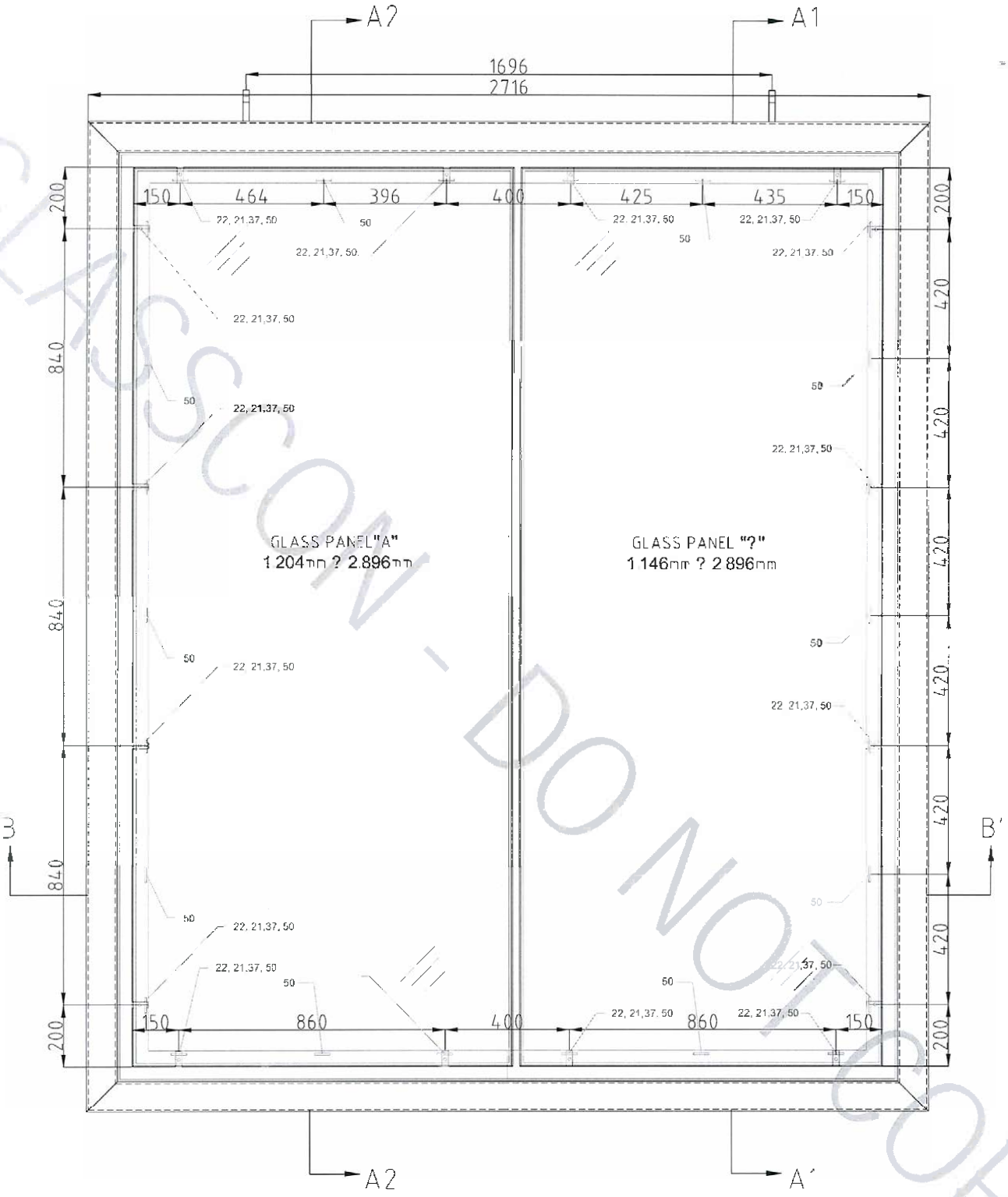


Fig. 1. Elevation of the tested sample
(declared nominal dimensions are expressed in mm)

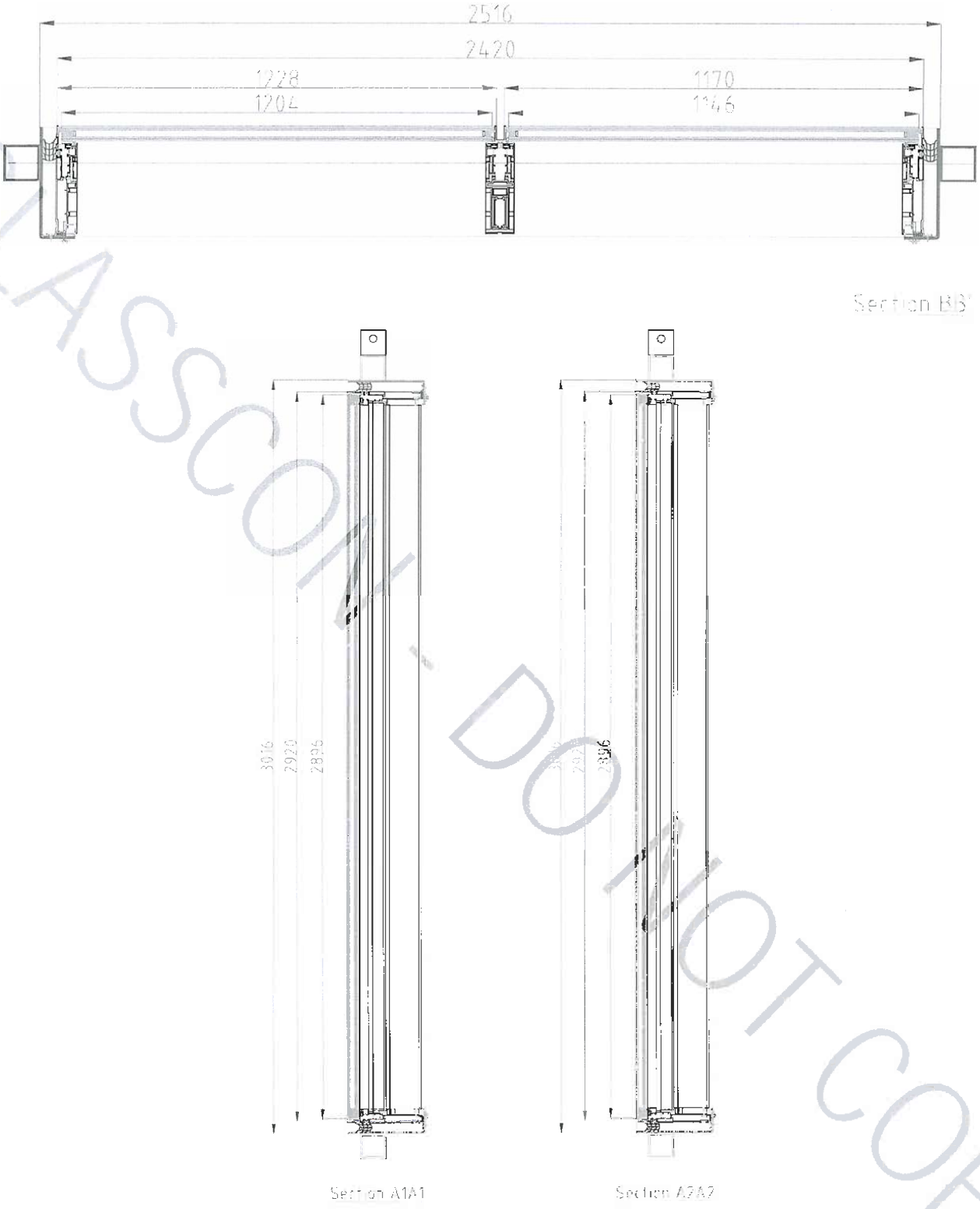


Fig. 2. Horizontal section B-B and vertical sections A-A (cf. Fig. 1) of the tested sample
(declared nominal dimensions are expressed in mm)

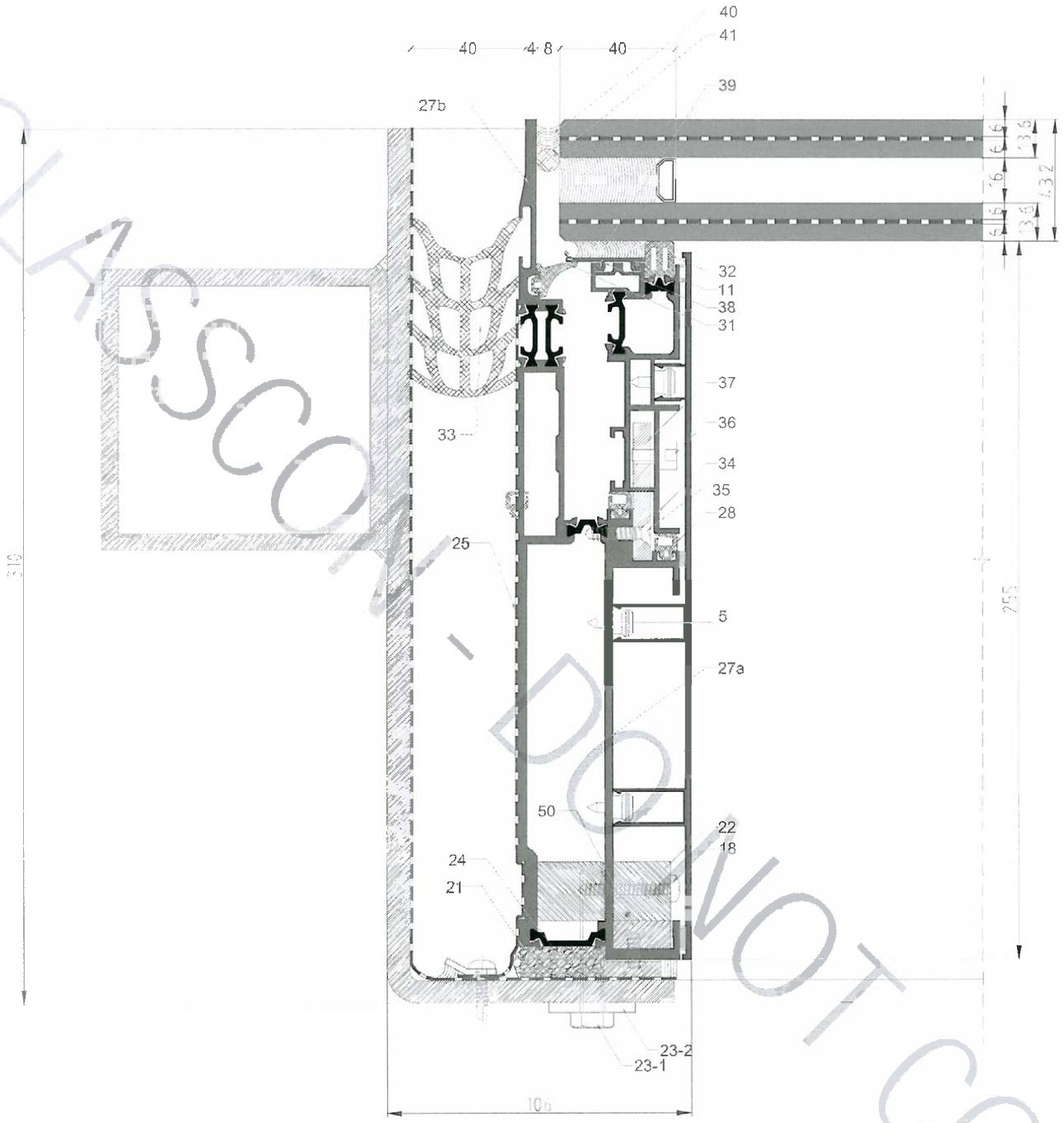


Fig. 3. Detail of the lateral node of the horizontal section B-B, of the tested sample (declared nominal dimensions are expressed in mm)

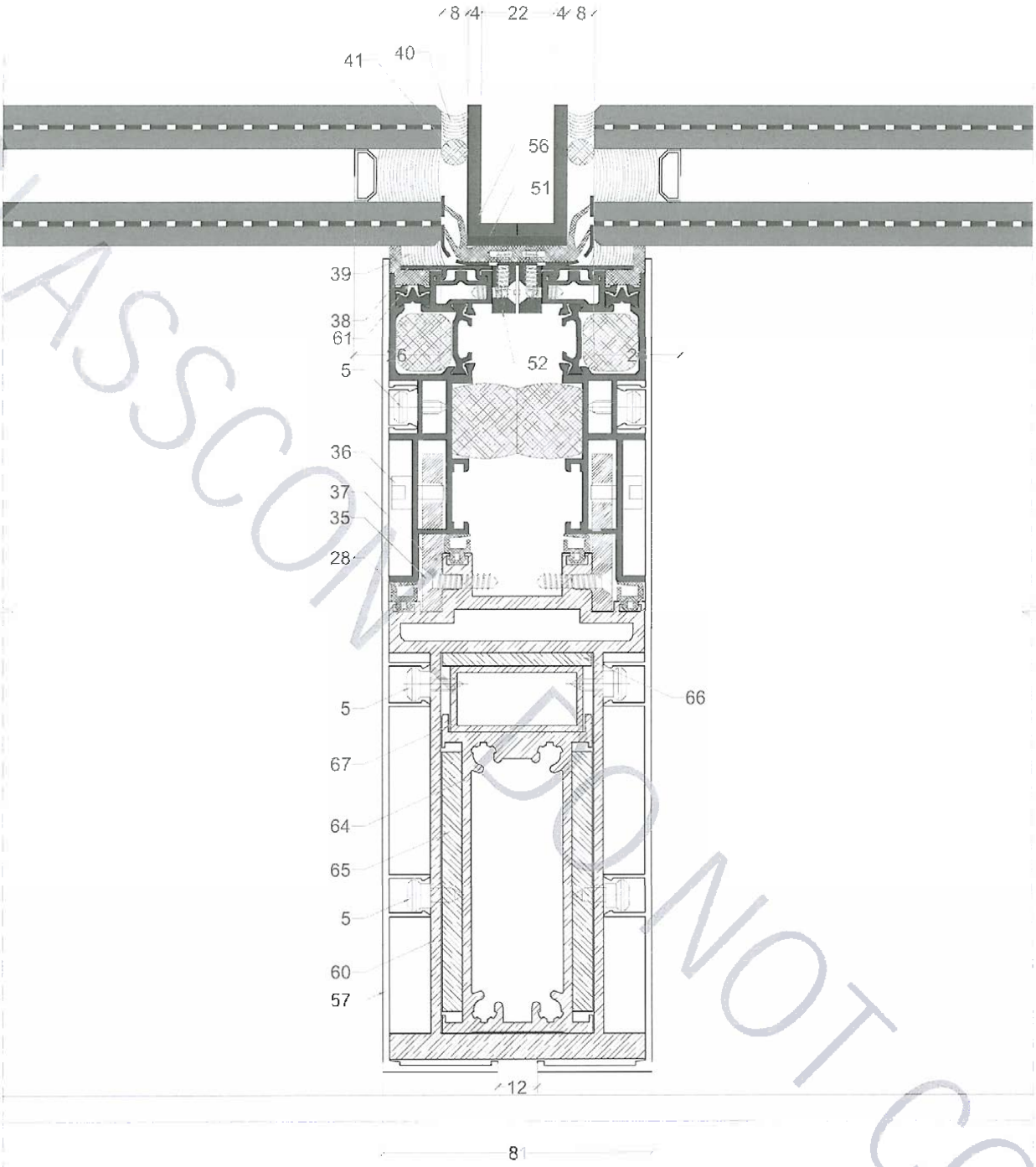


Fig. 4. Detail of the central node of the horizontal section B-B, of the tested sample (declared nominal dimensions are expressed in mm)

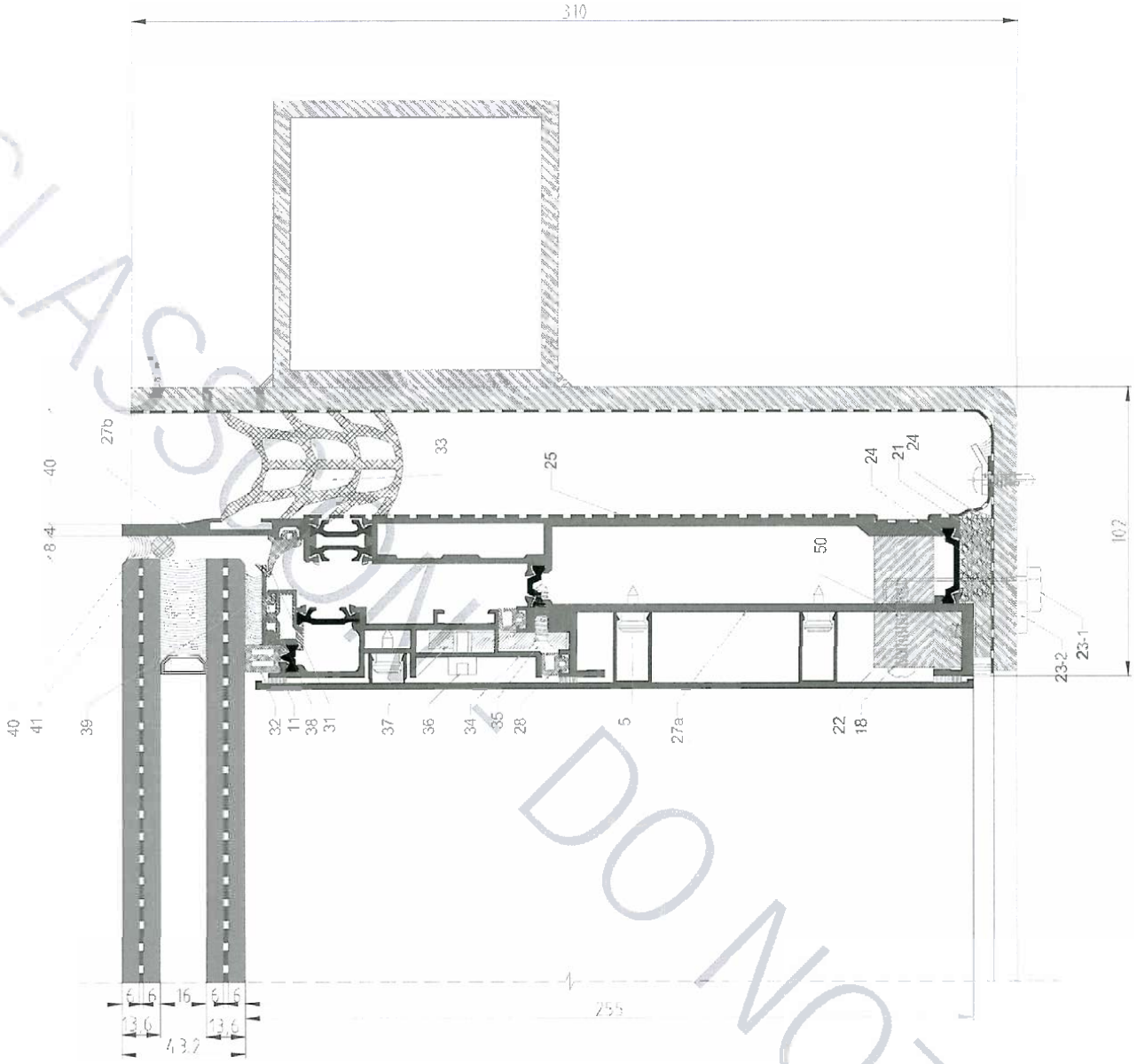


Fig. 5. Detail of the upper node of the vertical section A1-A1, of the tested sample (declared nominal dimensions are expressed in mm)

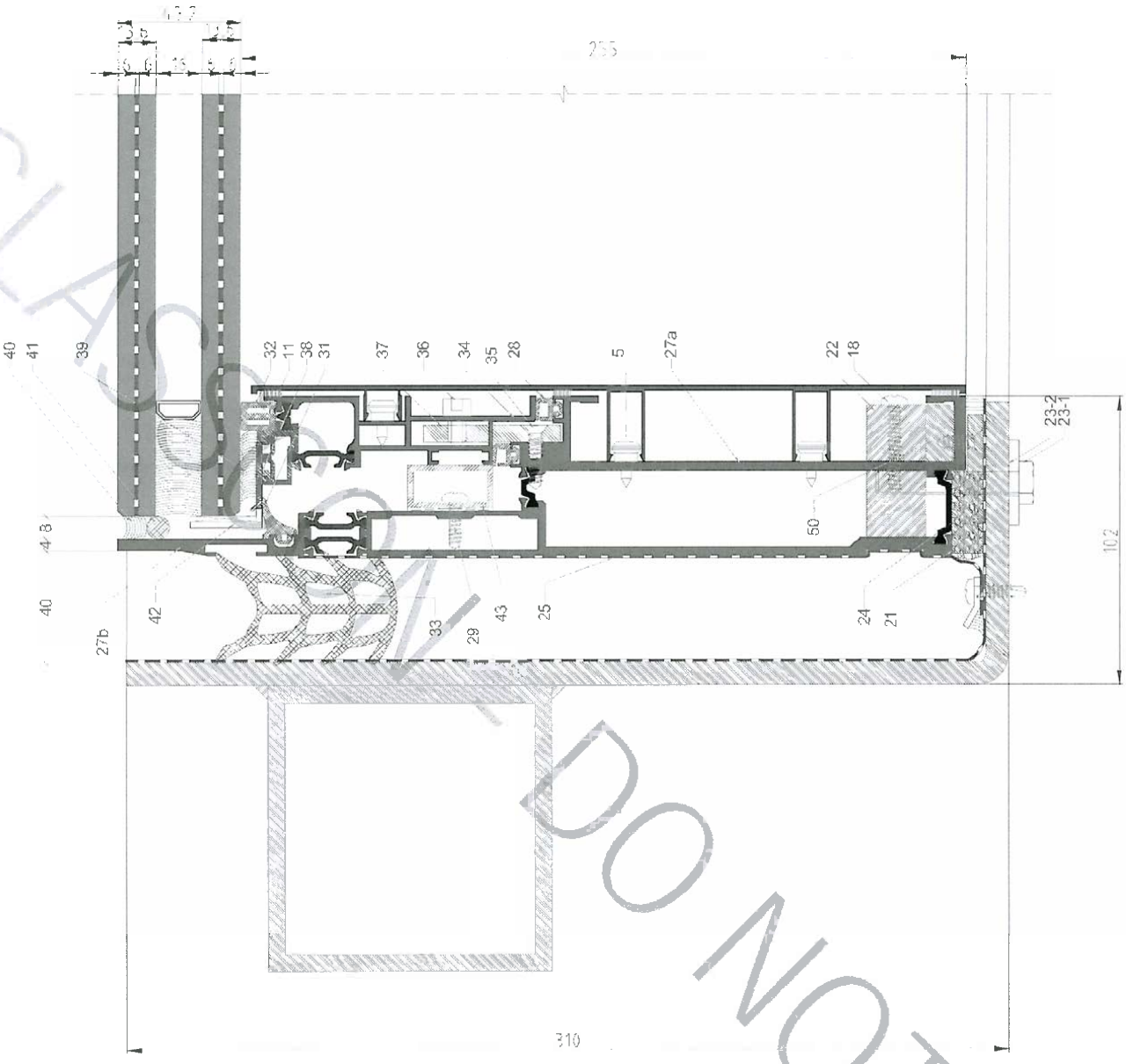


Fig. 6. Detail of the bottom node of the vertical section A1-A1, of the tested sample (declared nominal dimensions are expressed in mm)

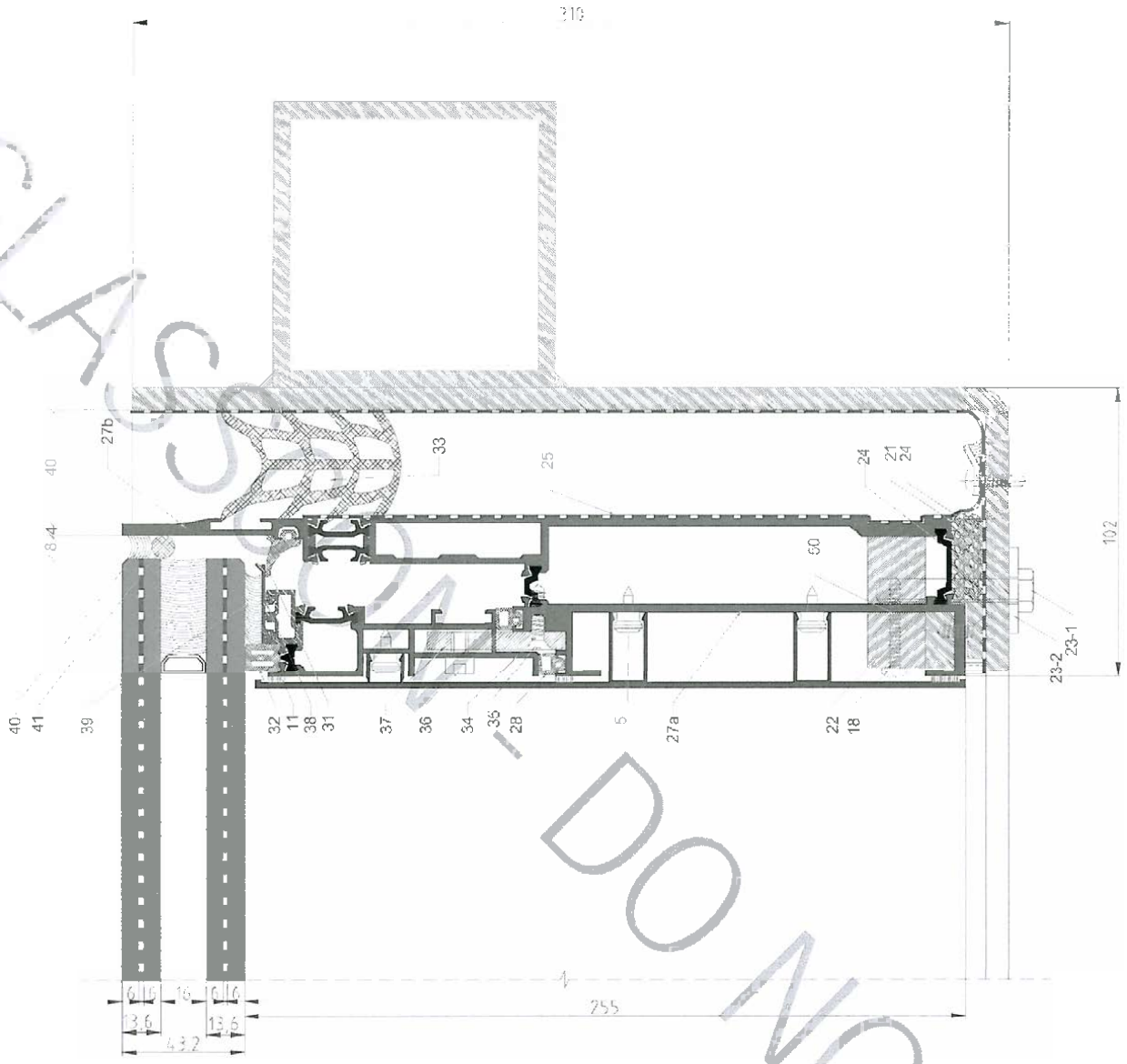


Fig. 7. Detail of the upper node of the vertical section A2-A2, of the tested sample (declared nominal dimensions are expressed in mm)

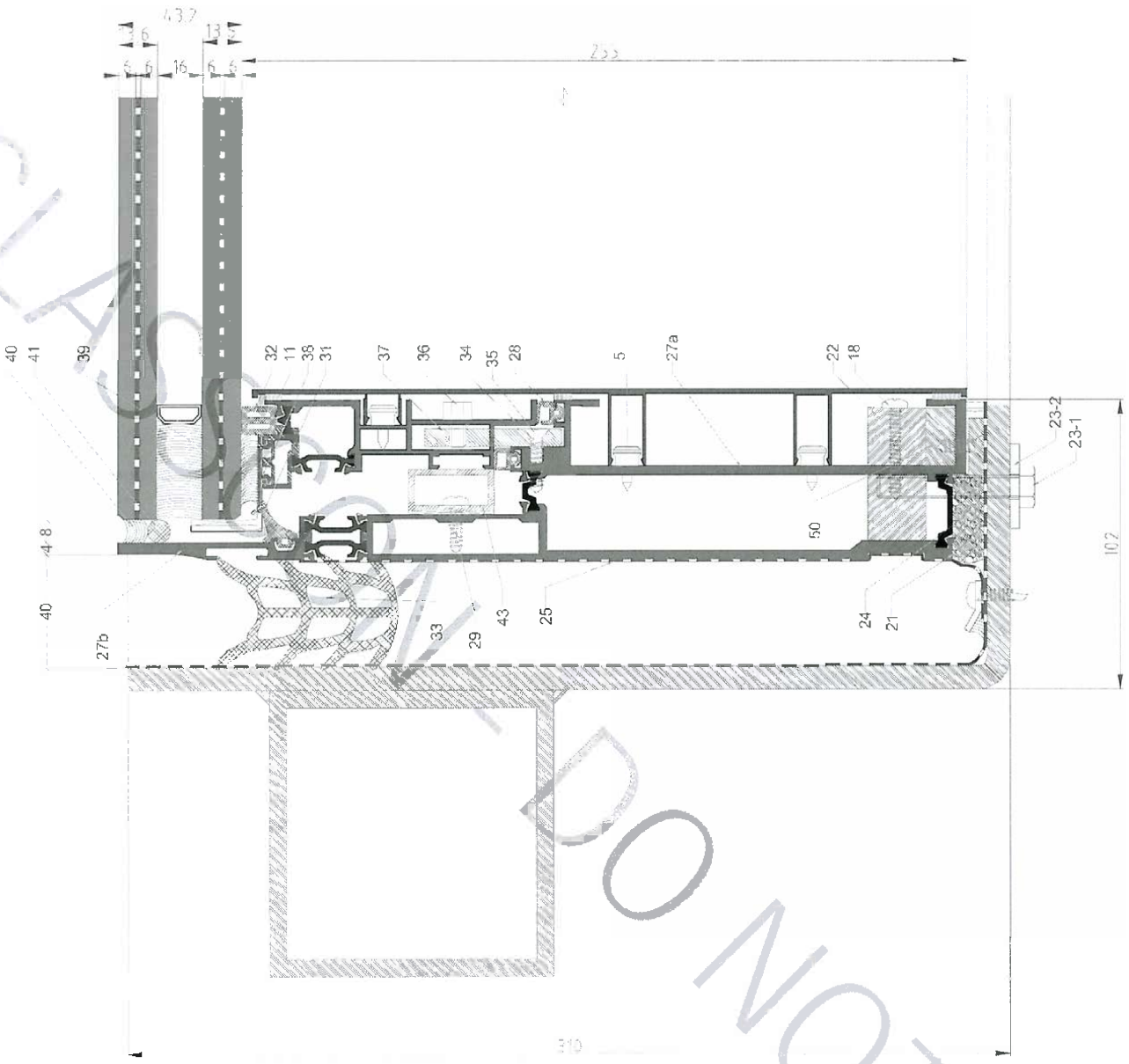


Fig. 8. Detail of the bottom node of the vertical section A2-A2, of the tested sample (declared nominal dimensions are expressed in mm)

PROFILES

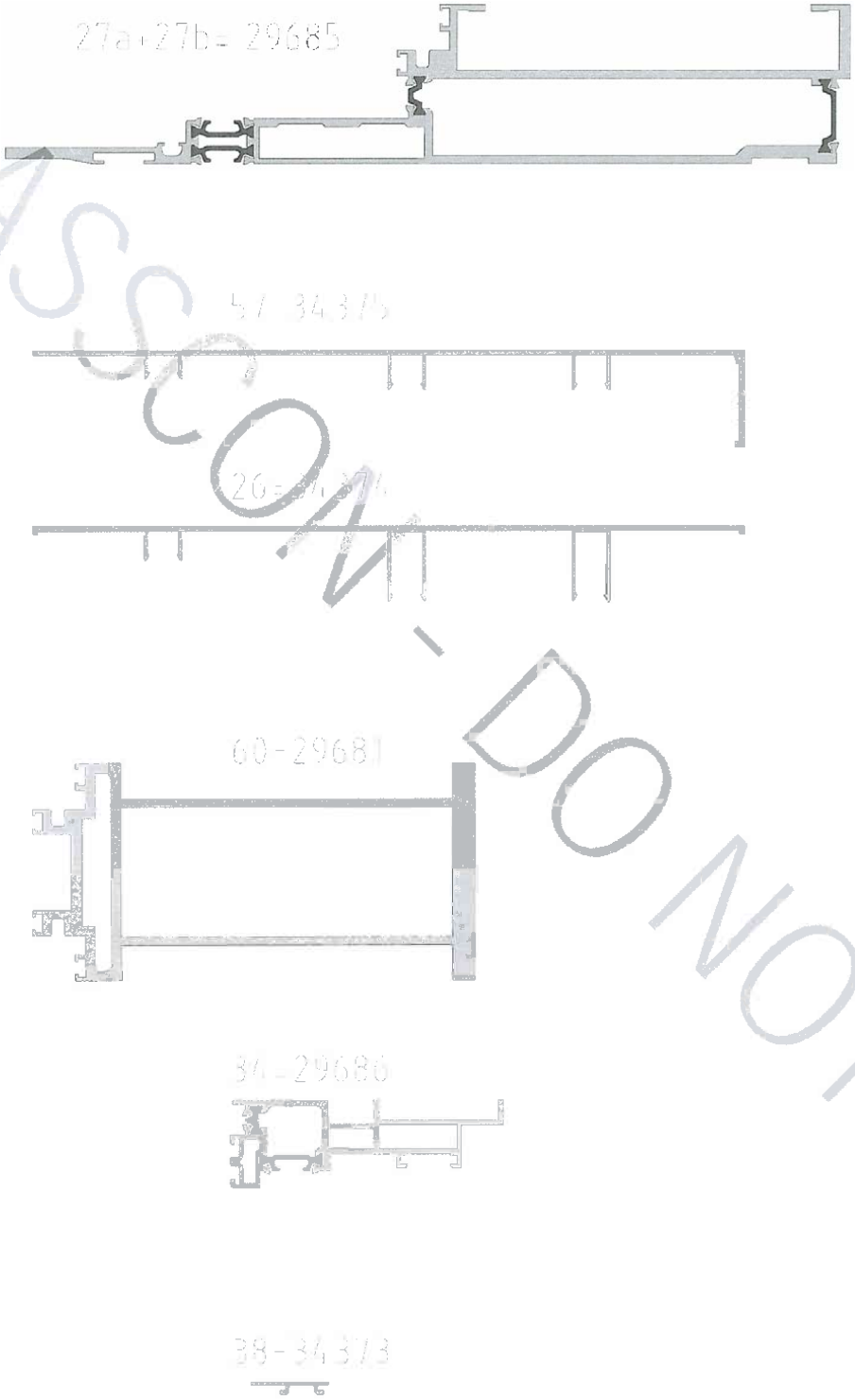


Fig. 9. Detail of the profiles of the tested sample
(declared nominal dimensions are expressed in mm)

GLAZING

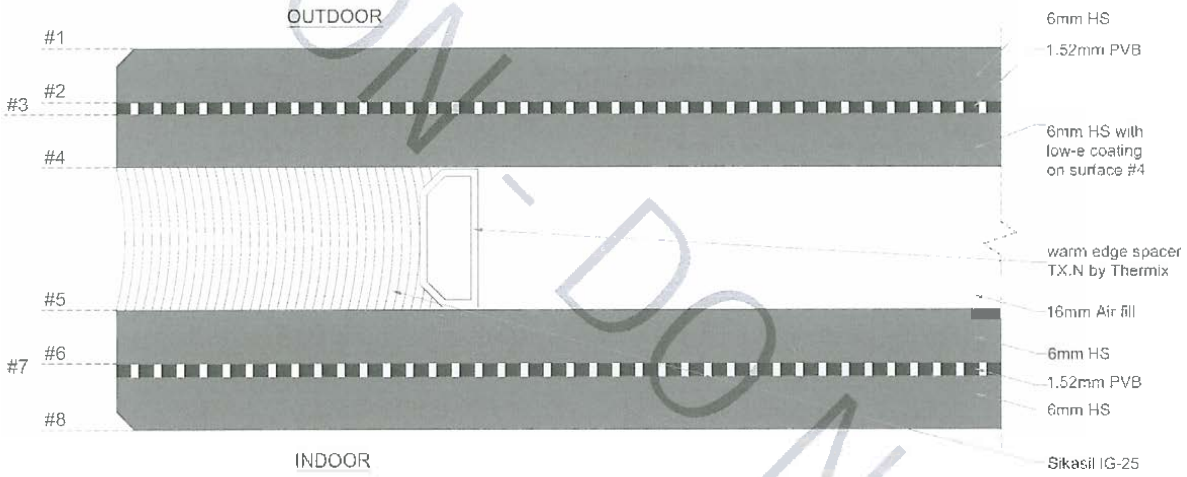


Fig. 10. Detail of the glazing of the tested sample
(declared nominal dimensions are expressed in mm)

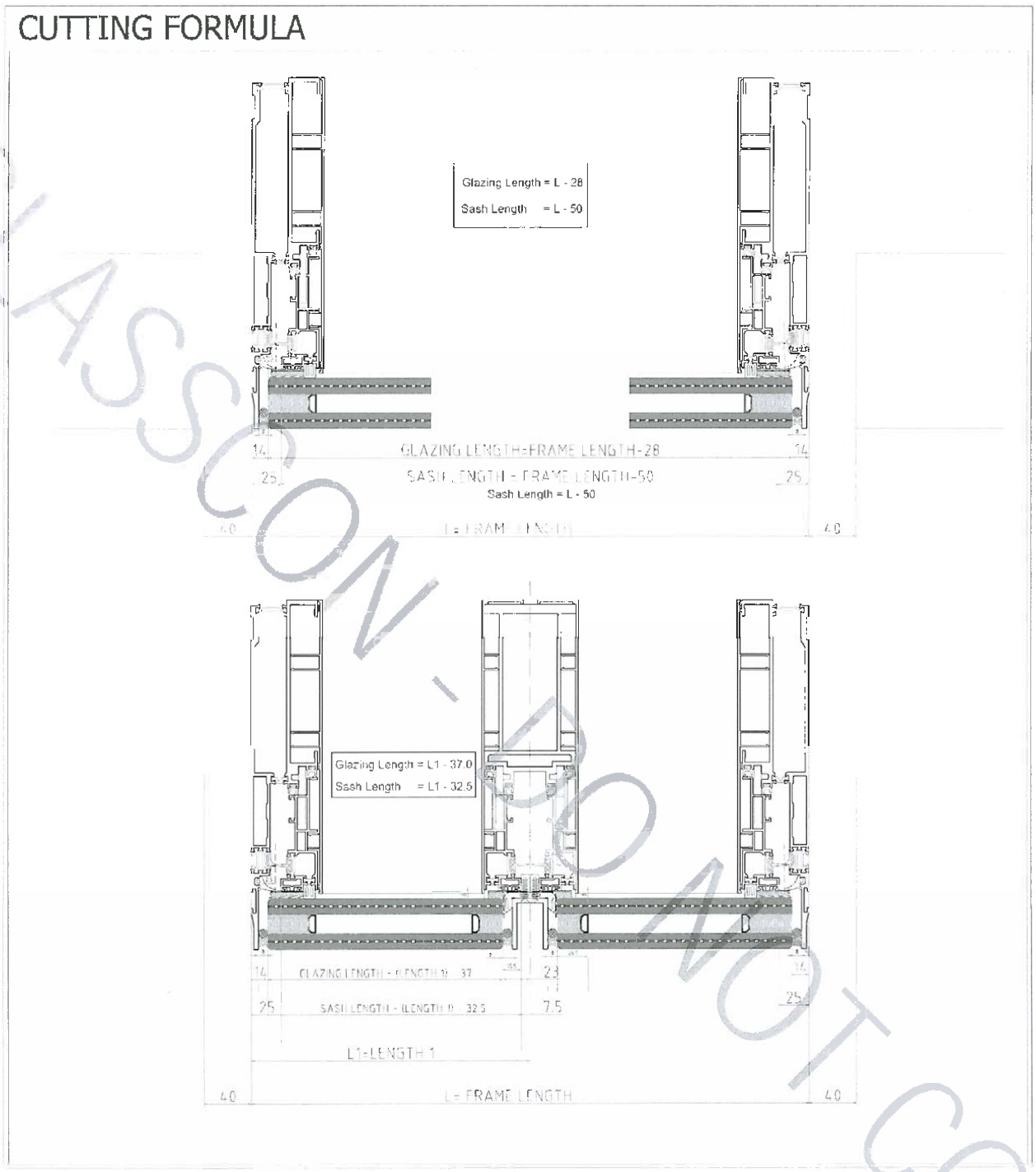


Fig. 11. Detail of the cutting formula of the tested sample
(declared nominal dimensions are expressed in mm)

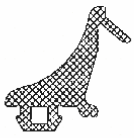
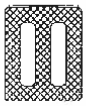
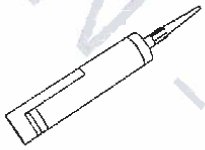
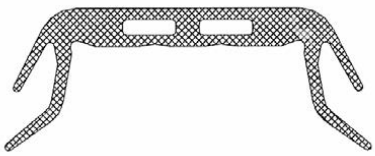
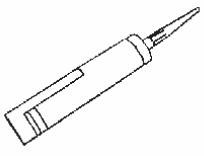
28		INTERNAL SEAL EPDM GASKET (FRAME) #06
31		CENTRE SEAL EPDM GASKET #05
32		SILICONE GASKET SPACER FOR GLAZING #32
33		WALL-JOINING GASKET FOR 40mm GAP #33
40		WEATHER SILICONE SIKASIL WS-605
41		PE CONTINUOUS BACKER ROD FOR 8mm
51		EPDM GASKET (MULLION) #51
61		SILICONE GASKET SPACER FOR GLAZING (MULLION SIDE) BACK #61
39		STRUCTURAL SILICONE, SIKASIL SG-500CN

Fig. 12. Detail of the accessories of the test sample – continue

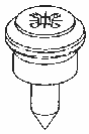
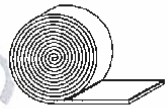
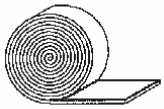
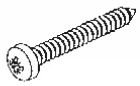
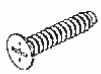
52		RECTANGULAR 7x15x200mm Aluminium or ACETAL (MULL ON SIDE) #52
5		NIPPLE SCREW WITH THREADED TIP 4x10mm code 0185586'00 WJERT-1
68		AL+BUTYL TAPE 80x1mm
11		SINGLE-SIDE FOAM BONDING TAPE, PE 10x2mm
24		EXPANDABLE FOAM TAPE
18		PAN HEAD TAPPING SCREW 4.8x32mm DIN ISO 7049
35		COUNTERSUNK HEAD TAPPING SCREW 4.8x19mm DIN ISO 7050
17		COUNTERSUNK HEAD TAPPING SCREW 4.8x22mm DIN ISO 7050
36		(SASH) HEXAGON SOCKET SCREW FOR PART No 37 M6x10mm DIN933 8.8

Fig. 13. Detail of the accessories of the test sample – continue

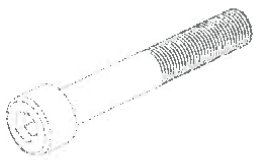
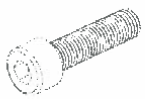
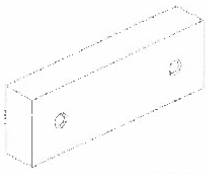
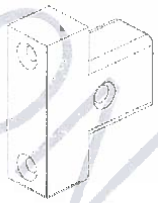
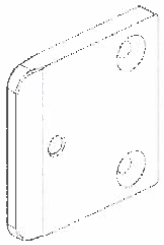
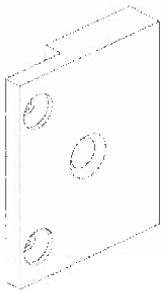
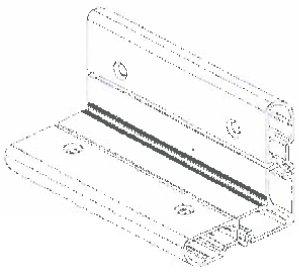
20		HEXAGON SOCKET HEAD CAP SCREW M10x65mm D.N912
19		HEXAGON SOCKET HEAD CAP SCREW M8x30 mm D.N912
50		SPACER, ALUMINUM OR METAL CUSTOM PART #50
22		ALUMINIUM CUSTOM PART # 22
37		ALUMINIUM CUSTOM PART # 37
21		SPACER, ALUMINUM OR METAL CUSTOM PART #21
46		EXTRUDED AL. JOINT CORNER BRACKET L=134.4mm, CODE 1140954

Fig. 14. Detail of the accessories of the test sample – continue

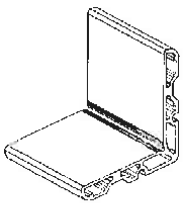
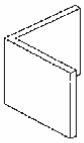
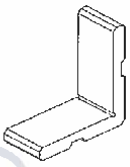
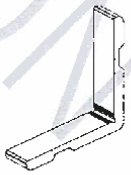
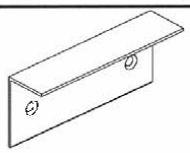
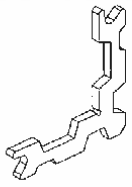
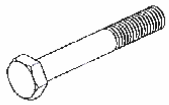
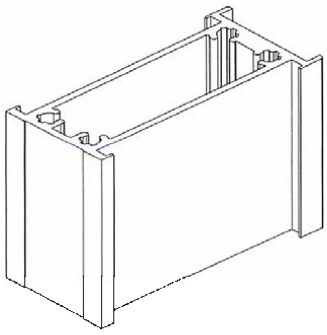
45		EXTRUDED AL JOINT CORNER BRACKET L=57.7mm, CODE #40950
44		ALIGNMENT ALUMINIUM SQUARE 25x25x2mm L=20mm, CODE #4064, ANODISED (AFTER CUTTING IN PIECES)
47		EXTRUDED ALUMINIUM JOINT CORNER BRACKET L=27mm SASH, CODE # 2364
48		EXTRUDED ALUMINIUM JOINT CORNER BRACKET L=15.5mm SASH, CODE# 40956
42		EXTRUDED ANODIZED ALUMINIUM CORNER FOR GLAZING SUPPORT 25x30x2mm L=100mm, CODE #17003
49		EXTRUDED AL JOINT CORNER BRACKET L=4mm SASH, CODE #2345
23		HEXAGON SOCKET SCREW M8x50mm DIN931 8.8
64		EXTRUDED ALUMINUM INSERT L=150mm CODE # 85954

Fig. 15. Detail of the accessories of the test sample – continue

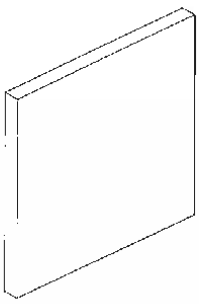
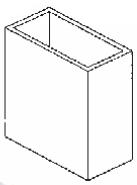
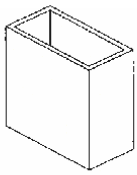
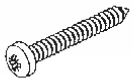
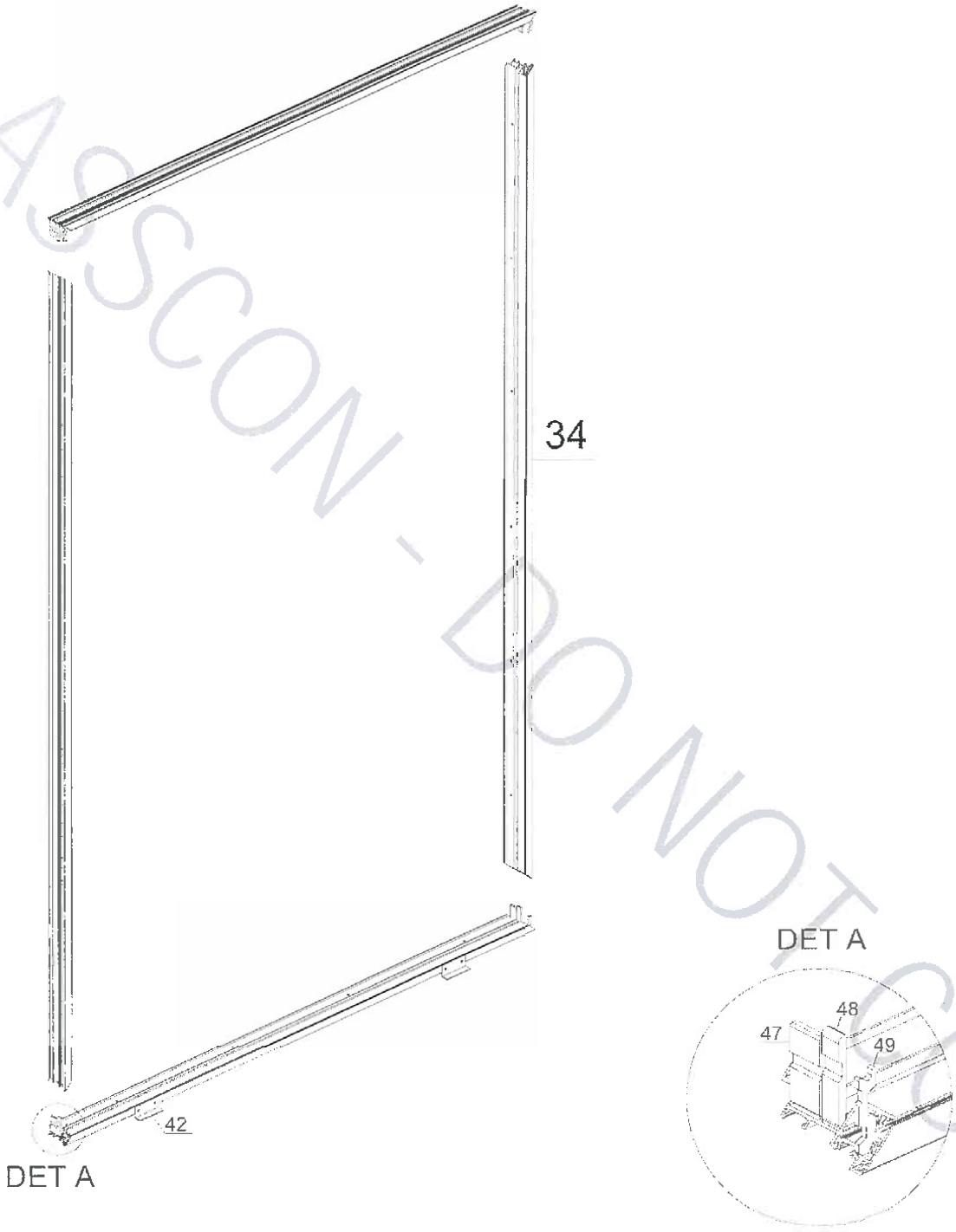
65		ALUMINUM SPACER PL 80x6mm L=150mm, CODE #9329
67		ALUMINUM SPACER, RHS 40x20x2mm L=150mm, CODE #7063
66		ALUMINUM SPACER PL 45x4 L=150mm, CODE #9062
25		EPDM MEMBRANE ' - 15 mm, 260mm
3		double sided bonding tape 2x10 mm
43		ALUMINIUM SPACER, RHS 30x15x2mm CODE #7072
29		PAN HEAD TAPPING SCREW 4.8x20mm D N ISO 7049

Fig. 16. Detail of the accessories of the test sample

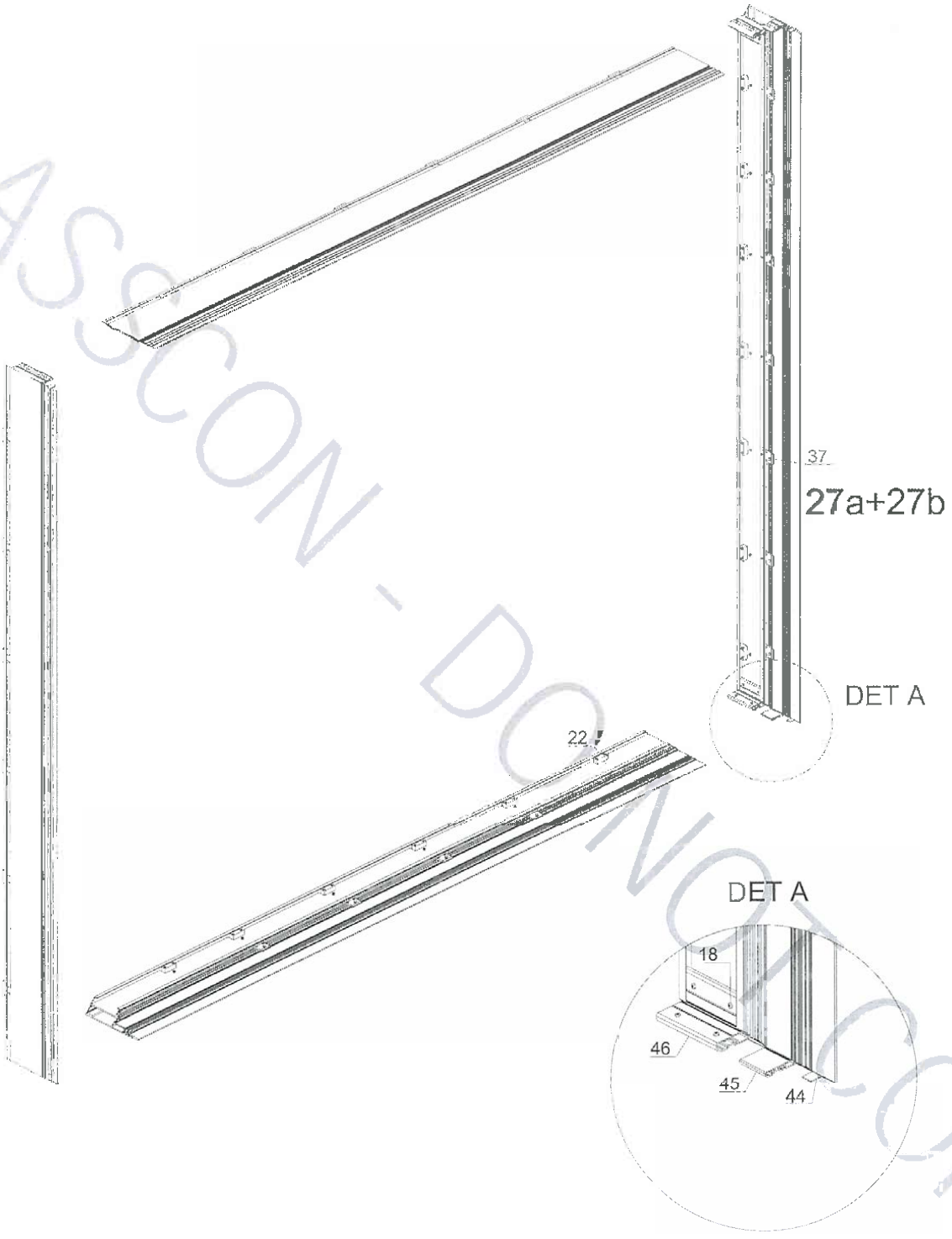
ASSEMBLY OF SASH



ALWAYS APPLY SEALANT AT THE JOINTS DURING ASSEMBLY

Fig. 17. Assembly of sash of the sample
(declared nominal dimensions are expressed in mm)

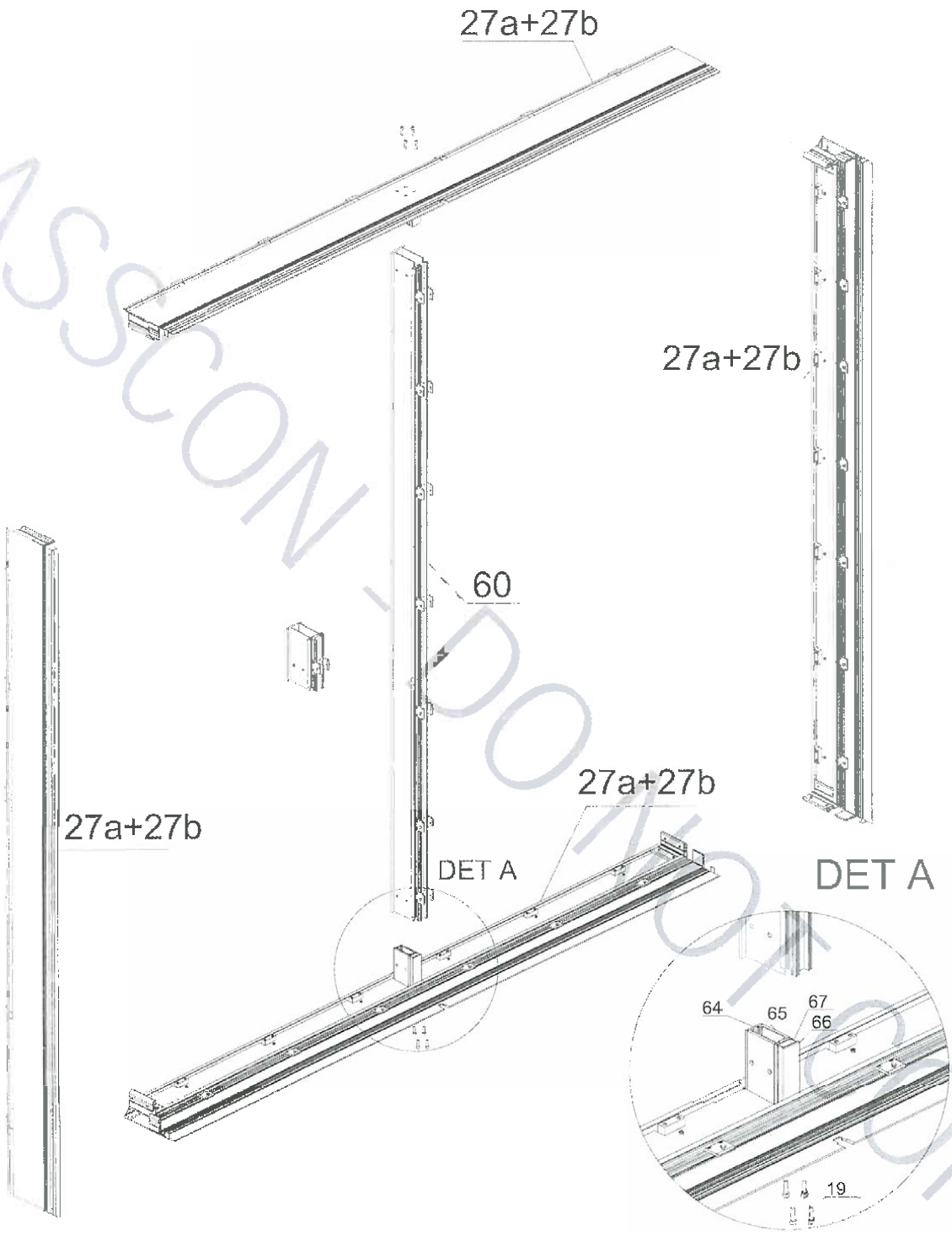
ASSEMBLY OF FRAME



ALWAYS APPLY SEALANT AT THE JOINTS DURING ASSEMBLY

Fig. 18. Assembly of frame of the tested sample
(declared nominal dimensions are expressed in mm)

ASSEMBLY OF FRAME WITH IMPOST



ALWAYS APPLY SEALANT AT THE JOINTS DURING ASSEMBLY

Fig. 19. Assembly of frame with impost of the tested sample
(declared nominal dimensions are expressed in mm)

INSTALLATION OF SASHES INTO FRAME

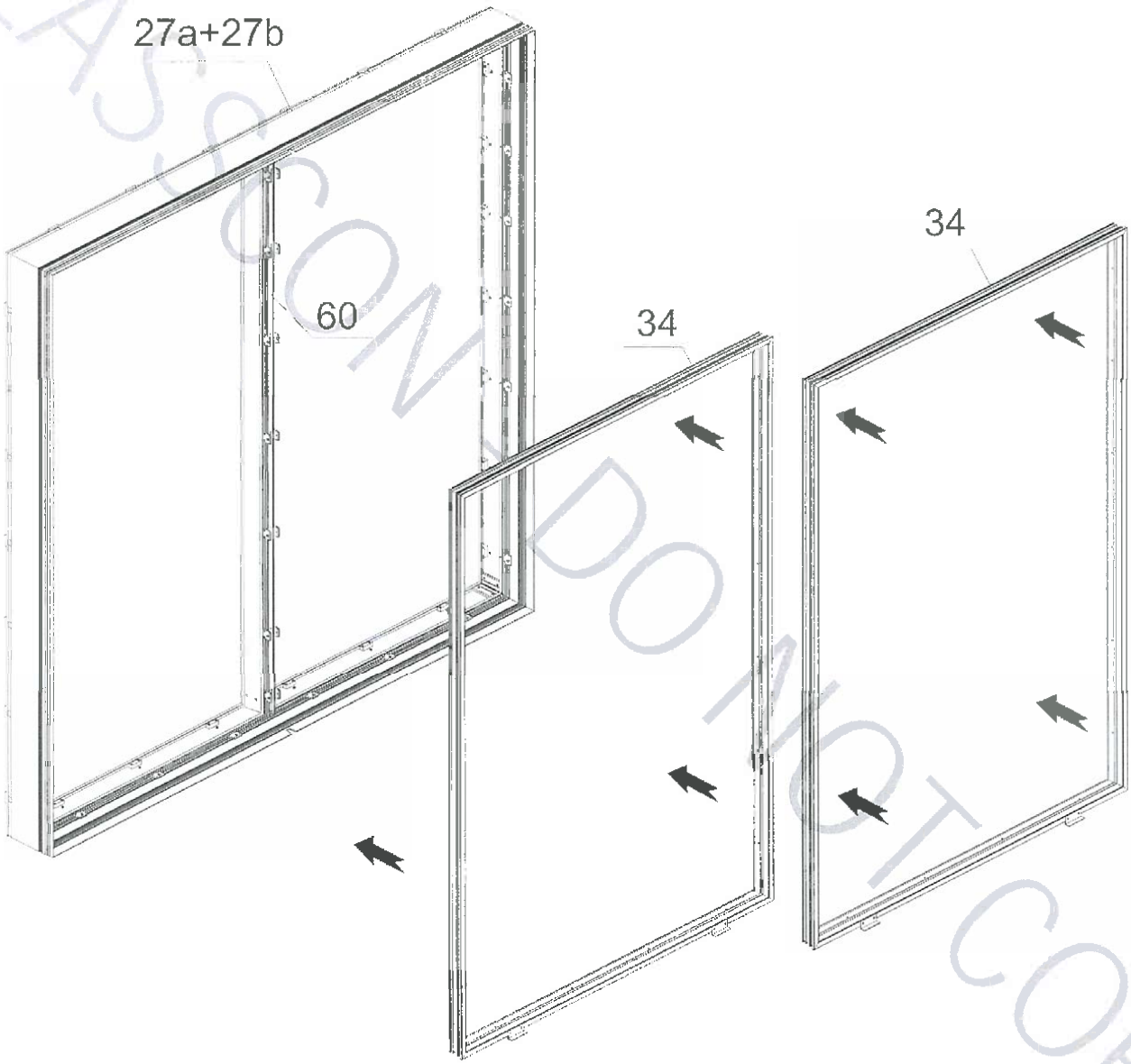


Fig. 20. Installation of sashes into frame of the tested sample
(declared nominal dimensions are expressed in mm)

INSTALLATION OF THE TWO "L" PROFILES IN THE JOINT BETWEEN THE SASHES

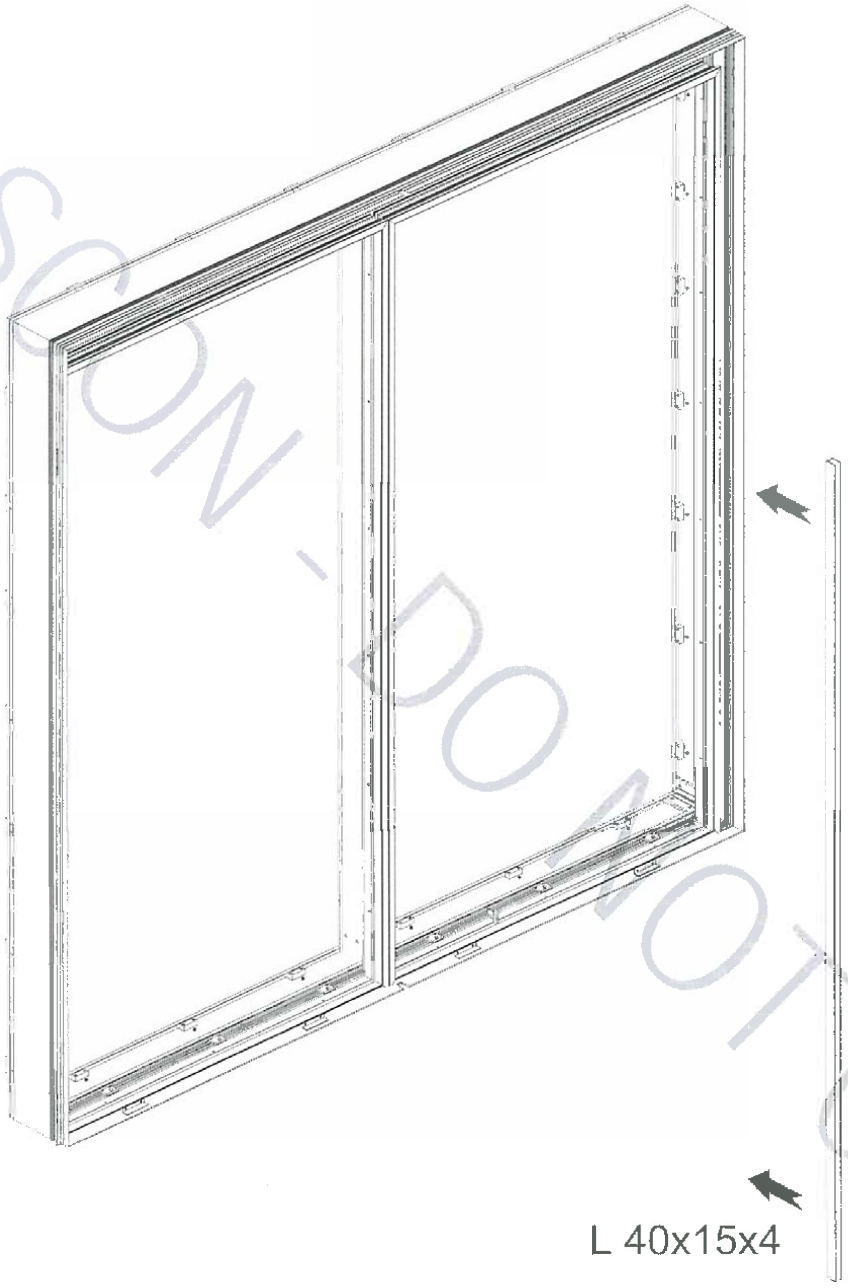


Fig. 21. Installation of the two "L" profiles in the joint between the sashes of the tested sample (declared nominal dimensions are expressed in mm)

INSTALLATION OF COVER CAPS

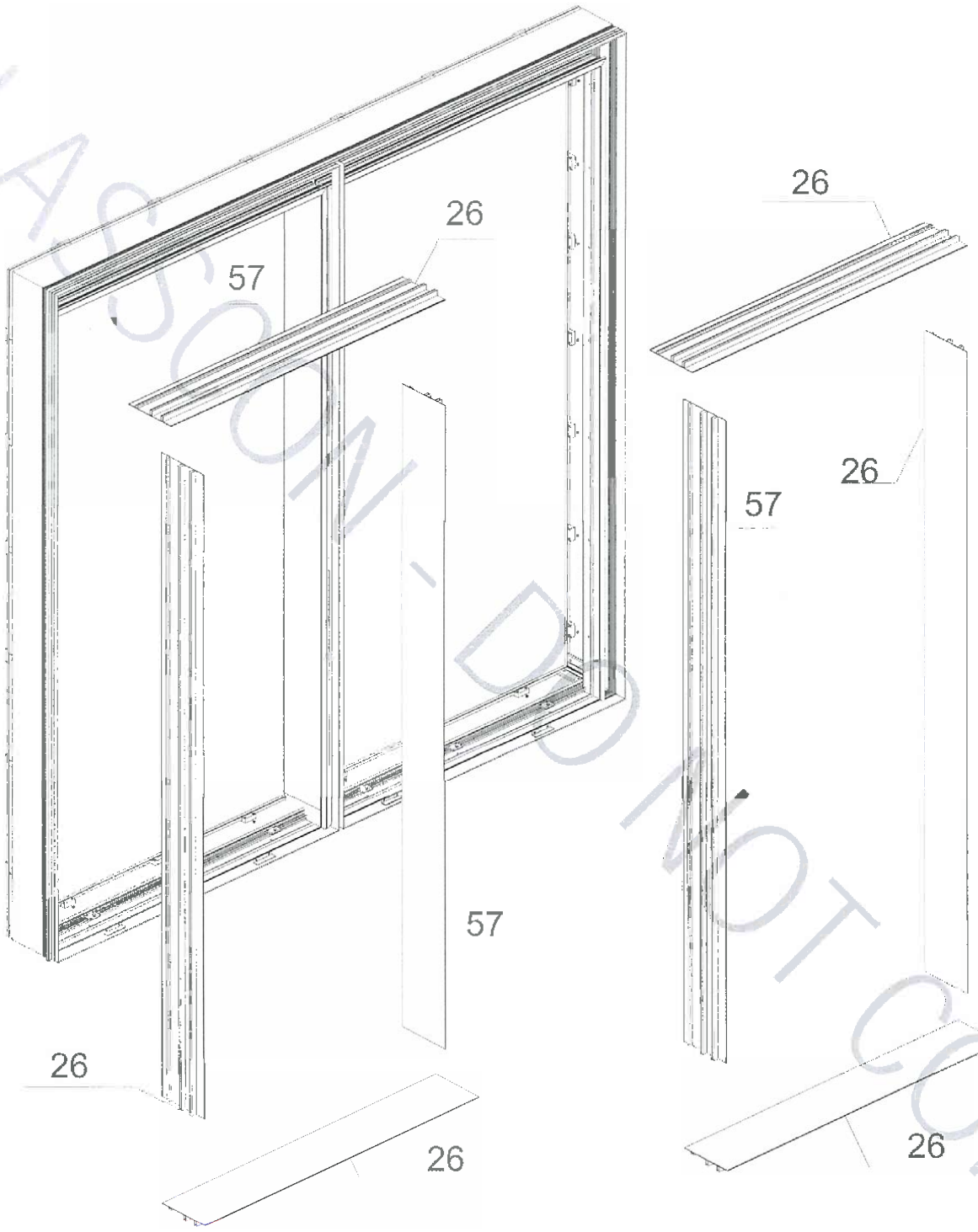


Fig. 22. Installation of cover caps of the tested sample
(declared nominal dimensions are expressed in mm)

MACHINING ON 60

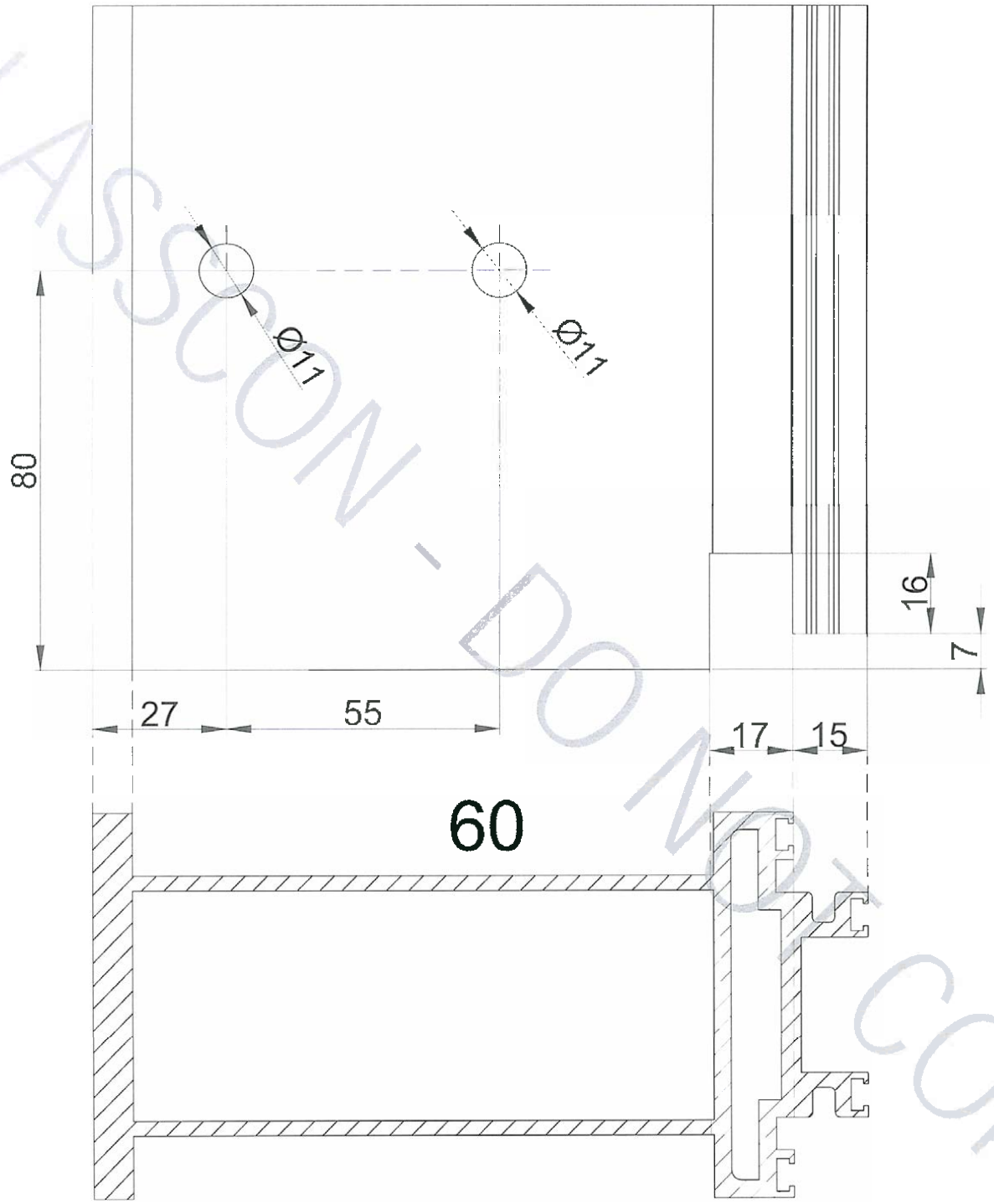


Fig. 23. Machining of the tested sample
(declared nominal dimensions are expressed in mm)

MACHINING ON 27a+27b FOR PART 64

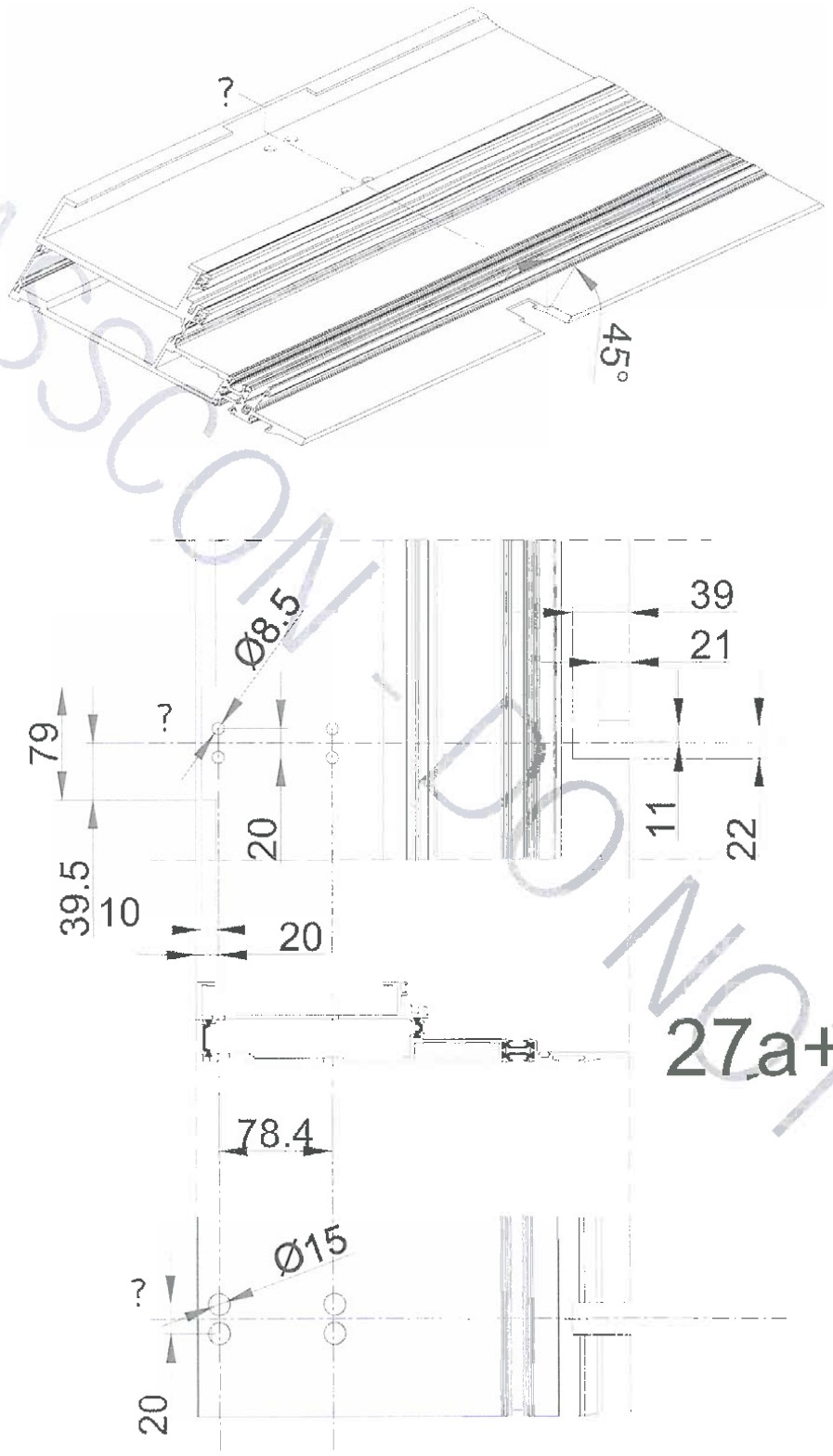
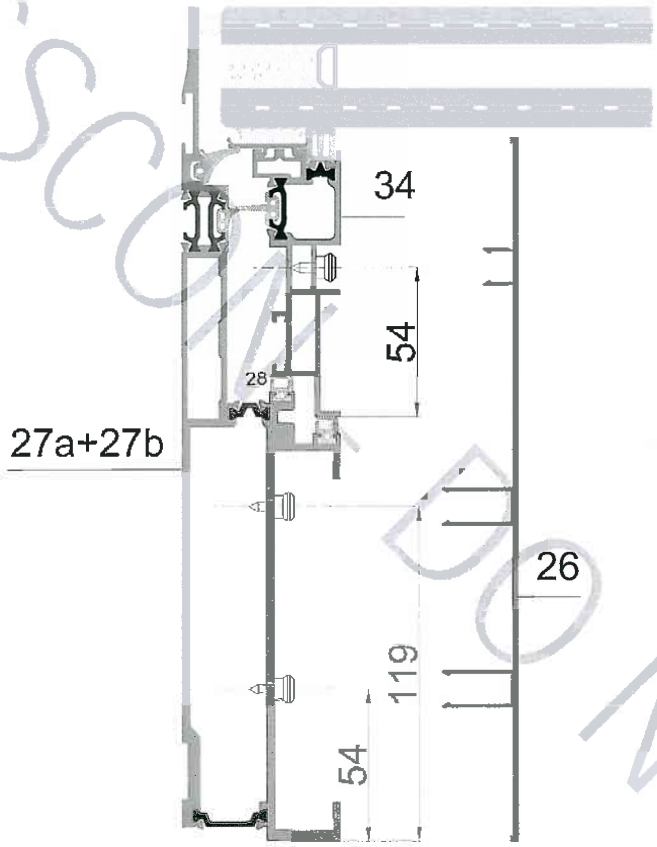
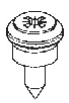


Fig. 24. Machining of the tested sample
(declared nominal dimensions are expressed in mm)

INSTALLATION OF NIPPLE SCREWS (PART 5) FOR FIXING 26

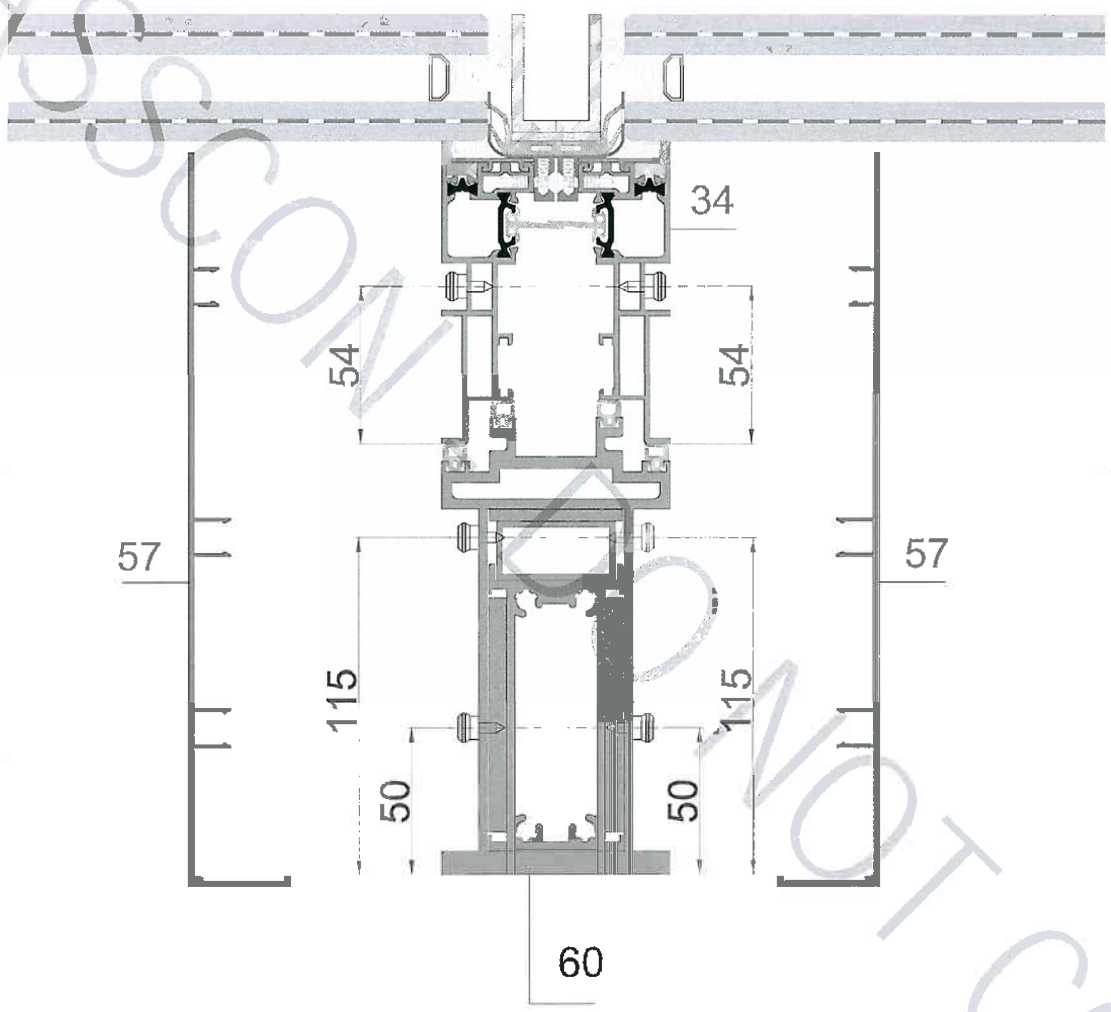




5

Fig. 25. Installation of nipple screws of the sample tested
(declared nominal dimensions are expressed in mm)

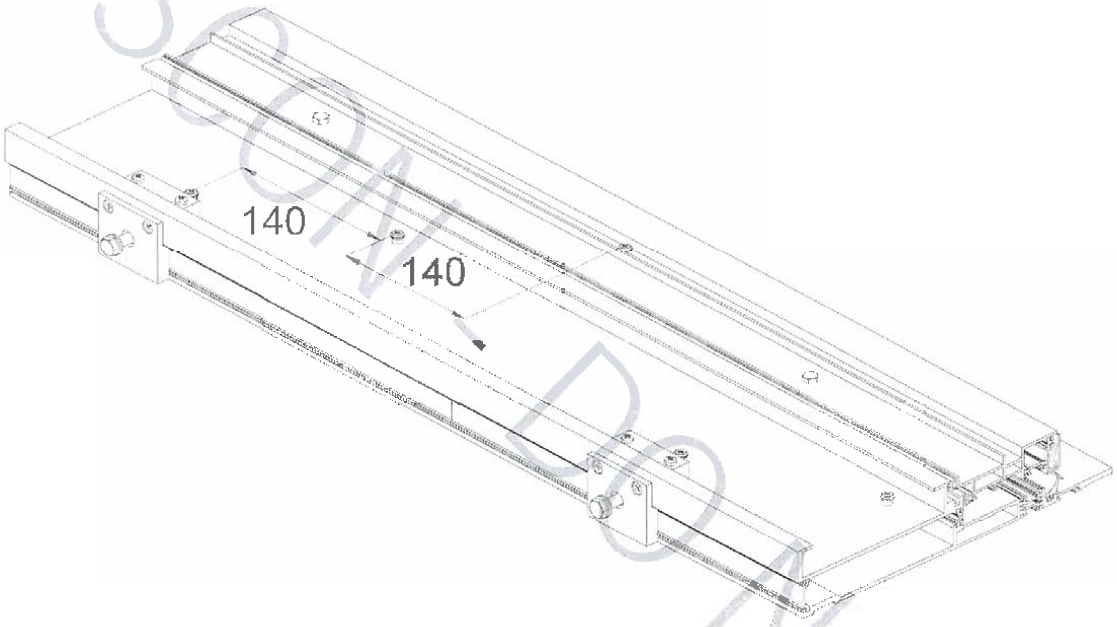
INSTALLATION OF NIPPLE SCREWS (PART 5) FOR FIXING 57



5

Fig. 26. Installation of nipple screws of the sample tested
(declared nominal dimensions are expressed in mm)

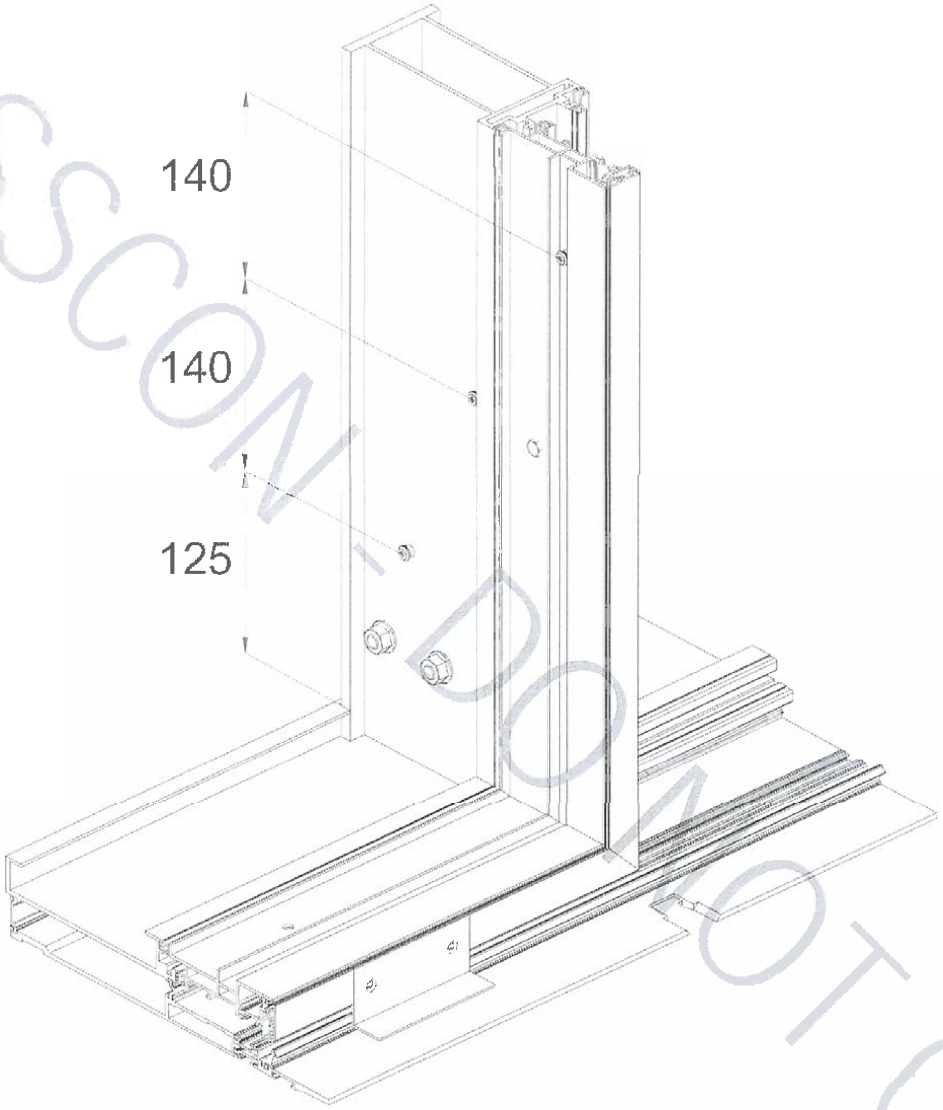
INSTALLATION OF NIPPLE SCREWS (PART 5) FOR FIXING 26



5

Fig. 27. Installation of nipple screws of the sample tested
(declared nominal dimensions are expressed in mm)

INSTALLATION OF NIPPLE SCREWS (PART 5) FOR FIXING 57



5

Fig. 28. Installation of nipple screws of the sample tested
(declared nominal dimensions are expressed in mm)

MACHINING ON 27a+27b FOR PART 22

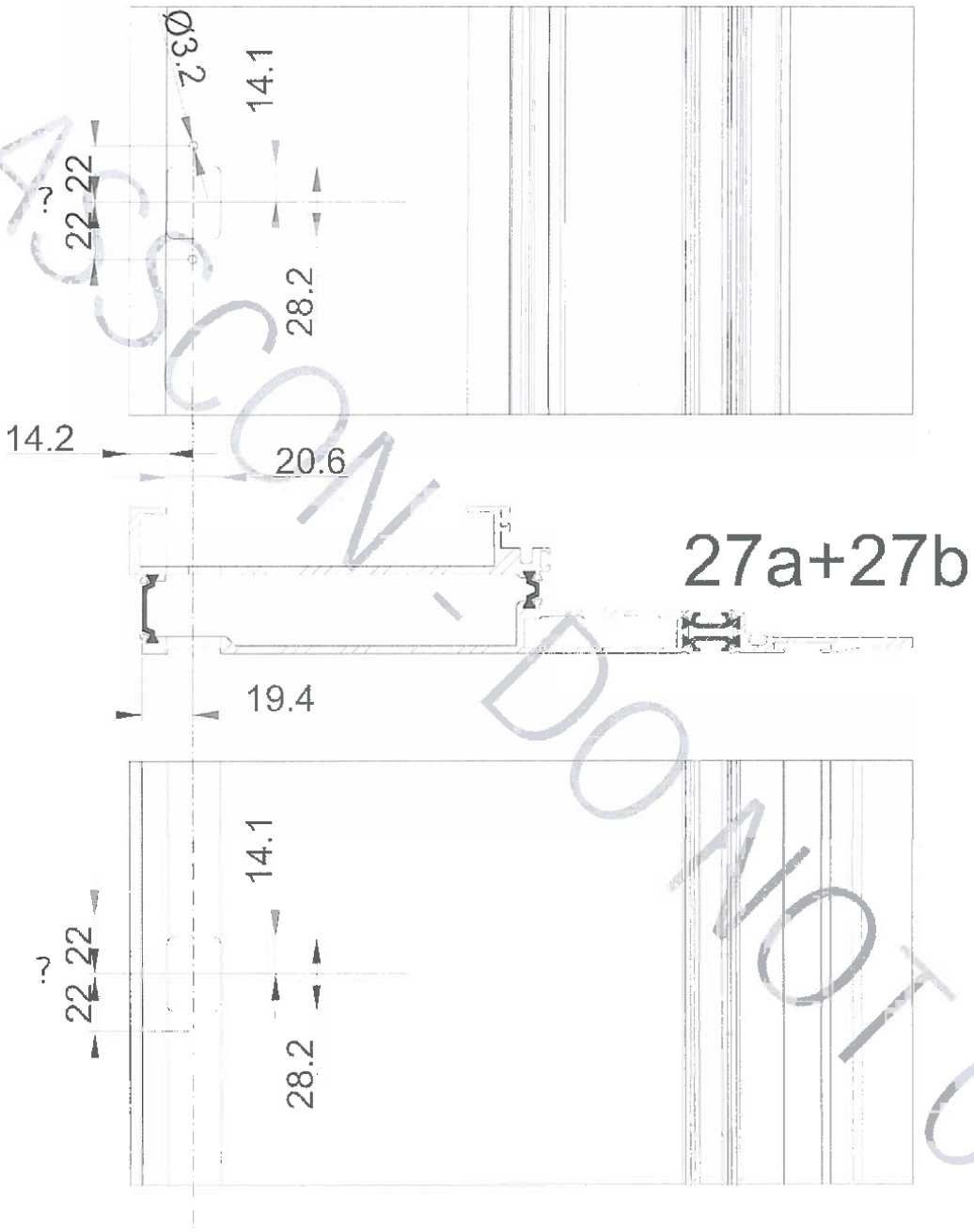


Fig. 29. Machining of the sample tested
(declared nominal dimensions are expressed in mm)

MACHINING ON 27a+27b FOR PART 21 & 16

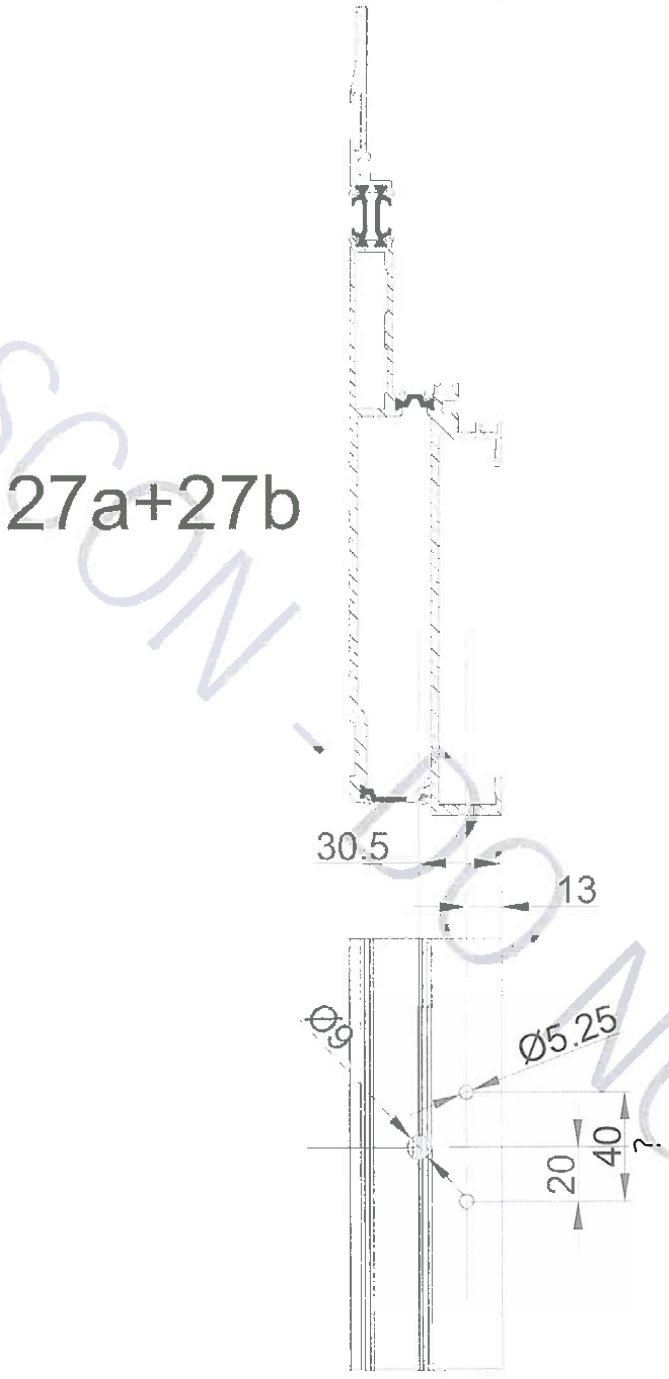


Fig. 30. Machining of the sample tested
(declared nominal dimensions are expressed in mm)

MACHINING ON 34 FOR PART 37

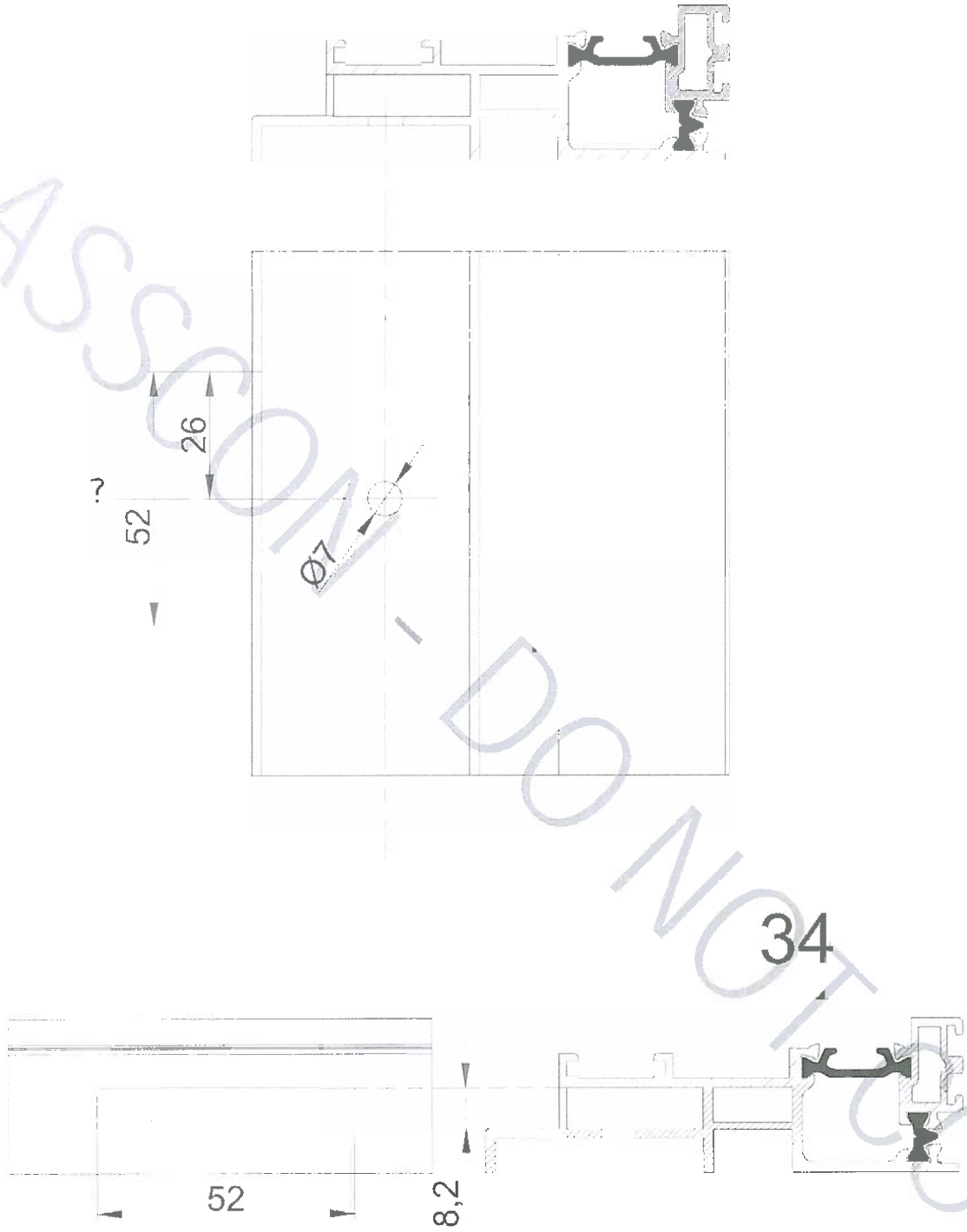


Fig. 31. Machining of the sample tested
(declared nominal dimensions are expressed in mm)

MACHINING ON 27a+27b FOR DRAINAGE

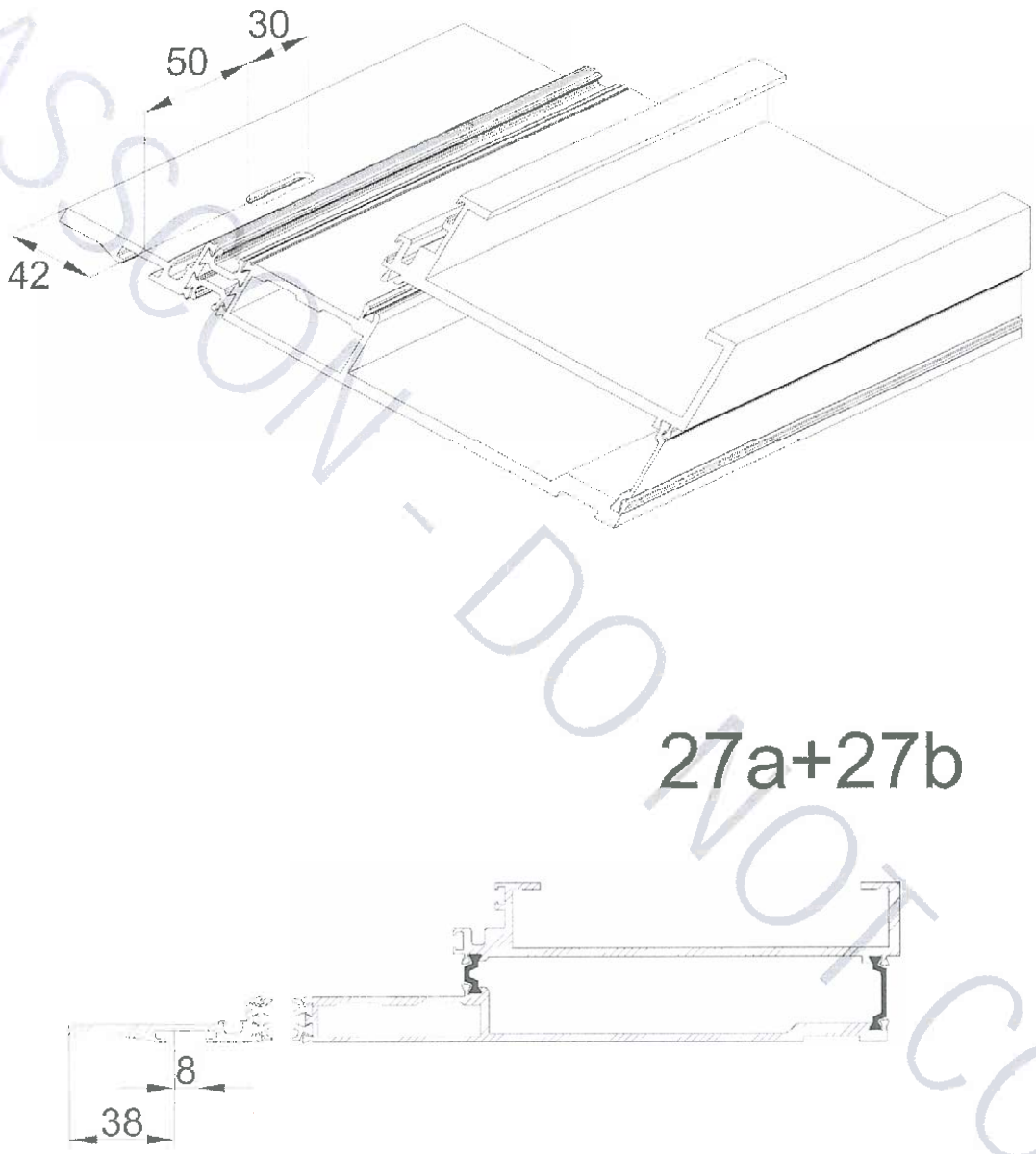
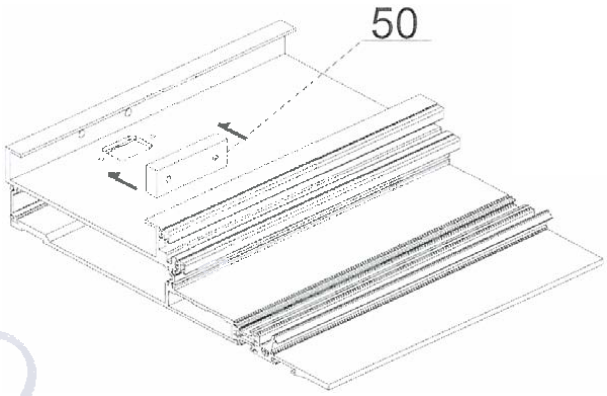


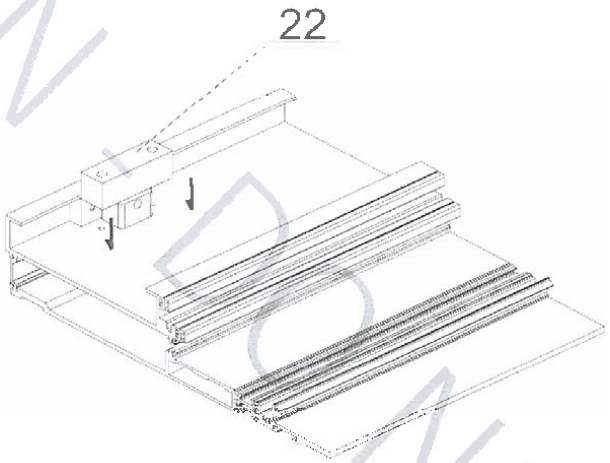
Fig. 32. Machining of the sample tested
(declared nominal dimensions are expressed in mm)

INSTALLATION OF PARTS 50, 7 & 22 ON 27a+27b

STEP 1



STEP 2



STEP 3

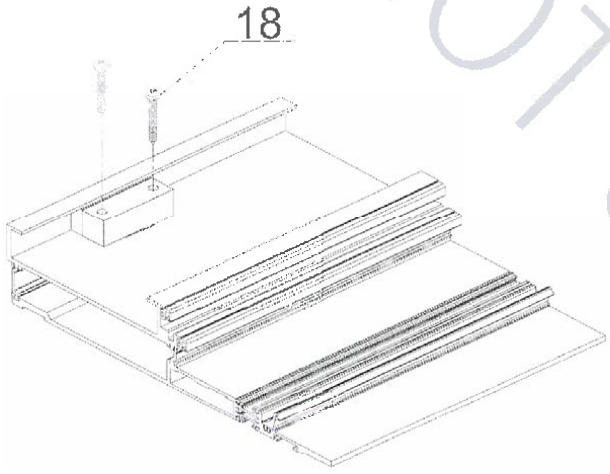
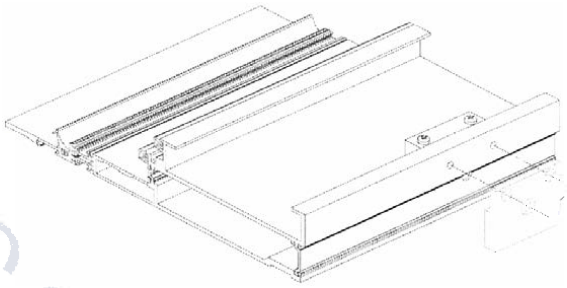


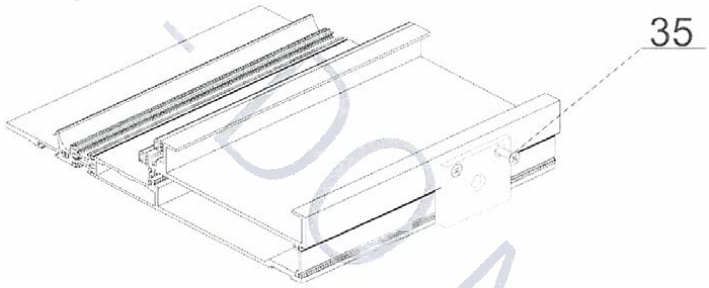
Fig. 33. Installation of parts of the sample tested
(declared nominal dimensions are expressed in mm)

INSTALLATION OF PARTS 16, 21 & 22 ON 27a+27b

STEP 4



STEP 5



STEP 6

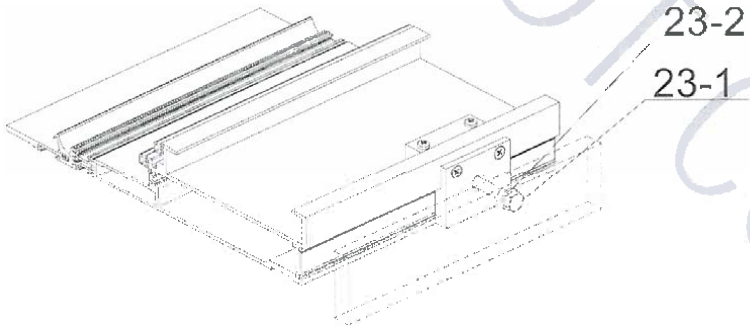
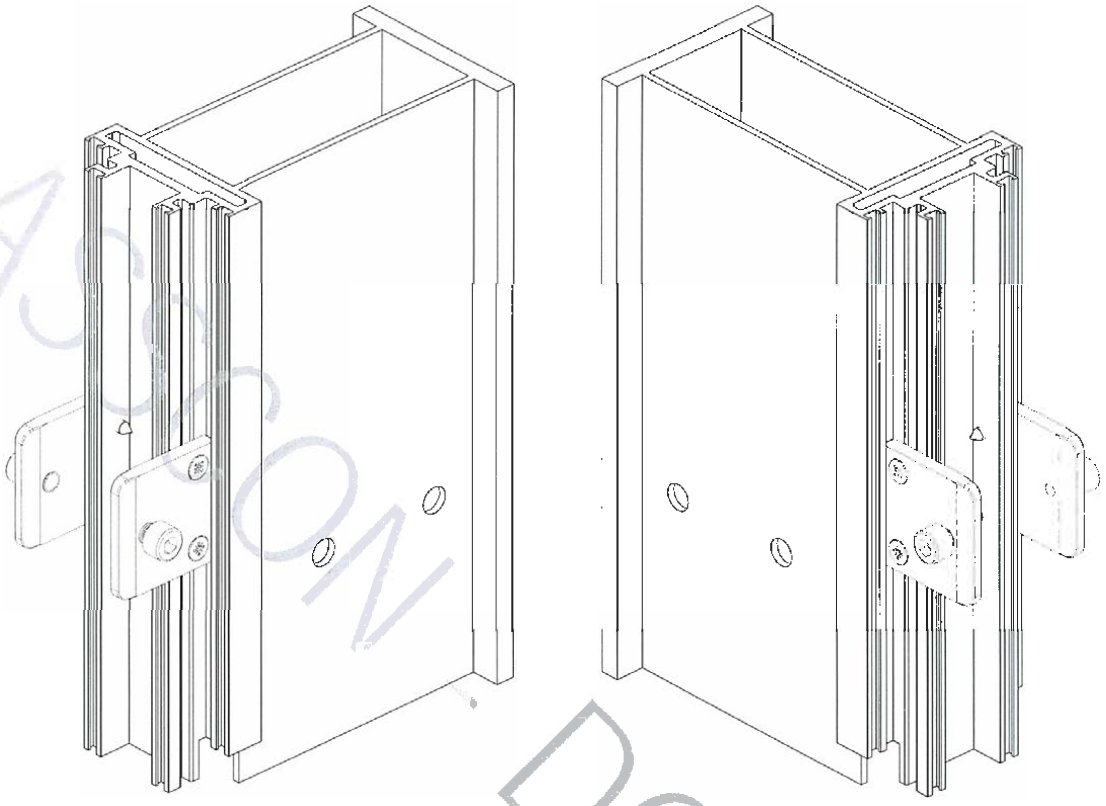


Fig. 34. Installation of parts of the sample tested
(declared nominal dimensions are expressed in mm)

INSTALLATION OF PART 37 ON 60



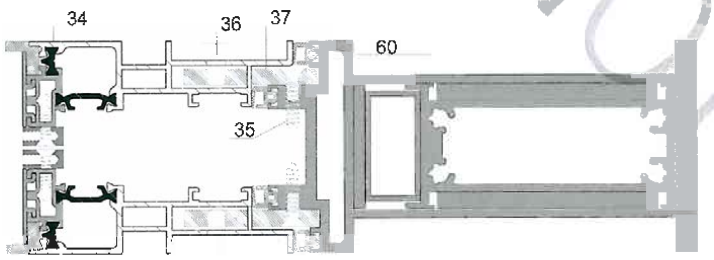


Fig. 35. Installation of parts of the sample tested
(declared nominal dimensions are expressed in mm)

2 Sampling Procedure

The product was sampled directly by the applicant, who indicated its traceability on the basis of the previously described code.

3 Samples preparation procedure

The sample (cf. Table 5 and photos § 9) was assembled directly by the applicant, realised the operative condition following the standards EN 13830:2003 and EN 12153:2000, 12155:2000 and 12179:2000. In particular the applicant declared to have carried out the following standards: the sample was selected as a representative of the range of products, the width not less than two typical units and enough to supply the full load on at least one typical vertical joint, on a cross-bar of the frame or on both and at a height not less than the total distance between the meeting point of the curtain walling to the structure of the building; the various parts of the sample have been realised under instruction by the applicant in conformity anticipated by the use of the works (material, details, construction and fastening methods and connection to the supporting structure). The sample was inserted by the applicant into the test chamber by fastening equivalent to normal use in both directions, levelled and squared, without torsions or visible curvature causable by the locking fastener. The test chamber, of sufficient resistance and rigidity to withstand the anticipated pressures and without deflections which could adversely affect the performance of the curtain walling, is which does not give additional rigidity to the sample. In preparation for the wind resistance test, devices to measure the maximum frontal movements of the cross-bar of the sample were installed, in order to evaluate the performance noted in conformity to EN 13116:2001.
A dimensional check of the sample was carried out prior to the test using a flexometer.

4 Test sequence

The sample was tested in the test laboratory of ETEM S.A., in Magoula on 2015-10-30 according to the unified test sequence as described in § 5.2.3 of the standard EN 13830:2003:

A. air permeability, for classification;
B. watertightness under static pressure, for classification;
C. resistance to wind load – serviceability;
D. air permeability - to repeat to confirm wind resistance classification;
E. watertightness - to repeat to confirm wind resistance classification;
F. resistance to wind load – increased wind resistance test (safety conditions).

5 Test method

The performed and described tests were carried out under Witness Testing regime on 2015-10-30 in the laboratory of ETEM S.A., in Magoula,1 Iroon Polytechniou str., directly by Eng. Michalis Koulianos, an operator of ETEM S.A., under the instruction of Katia Foti of IRcCOS S.c.a r.l...
Test equipment and the competence of the personnel have been subjected to a preventive check by IRcCOS S.c.a r.l. during an Audit on 2012-05-29 with positive outcome, then kept under periodical check.

5.1 Air permeability (test A, cf. § 4)

The test was performed in accordance with standard EN 12153:2000.

- *Principle of air permeability test:* it consists in the application of increasing and decreasing, positive and negative pressure steps, leak air being measured at each testing pressure, in order to determine the air permeability of both fixed and opening parts of the curtain wall.
- *Test procedure:* the test was subdivided into the following four phases.

  a Test under positive pressure: fixed part

  Prior to the test, all opening joints were sealed by means of adhesive tape in order to prevent any leak air. The test was then started by applying 3 positive air pressure pulses with rising time not less than 1 second; each pulse was maintained for at least 3 seconds with value 10% greater than the maximum test pressure P_{max}. Pressure was then zeroed and the test was continued by applying gradually increasing positive pressures with intervals of at least 10 seconds each, with 50 Pa increments up to 300 Pa followed by 150 Pa increments up to P_{max}, while recording the leak air values at each test pressure (Q_{fc}).

b Test under negative pressure: fixed part

The test sequence described above was followed closely in order to measure leak air at equivalent negative pressures.

c Test under positive pressure: whole sample

The air-tight seal on the sample's opening joints was removed and the opening joints of the sample were opened and closed five times then blocked in the closed position. Then the leak air values were measured at the equivalent test pressures(Q_{fc}).

d Test under negative pressure: whole sample

The test sequence described above was followed closely in order to measure leak air at equivalent negative pressures.

5.2 Watertightness under static pressure (test B, cf. § 4)

The test was performed in accordance with standard EN 12155:2000.

- *Principle of watertightness test under static pressure:* it consists in applying a specified and constant amount of water as a continuous film on the external surface of the sample with increments of the test positive static pressures applied at established intervals, in order to determine the watertightness of both fixed and opening parts of the curtain wall.
- *Test procedure:* the test started by applying 3 positive air pressure pulses with rising time not less than 1 second; each pulse was maintained for at least 3 seconds with value 10% greater than the maximum test pressure P_{max}. Water delivery, set at 2 l/m^{2}m as to the calculated area of the curtain wall, was executed first without pressure for 15 minutes then with 50 Pa increments up to 300 Pa and starting from 300 Pa with increments of 150 Pa corresponding to 5 minutes each interval, until the maximum test pressure P_{max} was reached. At the same time, the sample was constantly inspected to observe the presence, duration and location of possible water seepages during the whole water spraying period.

5.3 Resistance to wind load – test under design load conditions (test C, cf. § 4)

The test was performed in accordance with standard EN 12179:2000.

- *Principle of resistance to wind load test*: it consists in applying an established sequence of test pressures in order to determine the resistance to wind load of both fixed and opening parts of the sample, under conditions of positive and negative static air pressure.
- *Test procedure:* the test was subdivided into two successive phases: one with positive pressure and one with negative pressure, after opening and closing 5 times the opening parts of the sample.

  Test under positive pressure:

  The test was started by applying 3 positive air pressure pulses with value equal to 50% of the declared design wind load (cf. Table 12), each pulse was maintained for at least 3 seconds with short rising time not less than 1 second. After setting the deformation measuring devices back to zero, the test was continued by applying increasing pressures in 4 steps, with values corresponding to 25%, 50%, 75% and 100% of the design wind load; each of them was maintained for at least (15±5) seconds. The values of frontal displacements of the characteristic points and residual deformations were measured and recorded at each test pressure step in order to determine the frontal deflections of the sample.

  Test under negative pressure:

  The same procedure described for the test under positive pressure was used here with negative pressure.

5.4 Air permeability (test D, cf. § 4)

The test was repeated following the methodology described at § 5.1.

5.5 Watertightness (test E, cf. § 4)

The test was repeated following the methodology described at § 5.2.

5.6 Resistance to wind load – test under increased load conditions - safety conditions

5.7 (test F, cf. § 4)

- *Test procedure:* the test involved the application of positive and negative test pressure equating to 150% of the declared design wind load for at least (15±5) seconds. The opening module was opened and closed five times then blocked in the closed position.

6 Test equipment

The equipment used to perform the tests, in accordance with § 5 of standards EN 12153:2000, 12155:2000 and 12179:2000, consists of:

- a wall with an open side to house the test sample;
- a device allowing to create a controlled pressure difference between the sample's faces;
- a device allowing to obtain a quick and controlled variation of pressure difference within specified limits;
- an instrument to measure the incoming and outgoing air-flow through the airtight chamber
- an instrument to measure pressure difference between the sample's faces;
- an instrument that measures the temperature inside the airtight chamber;
- an instrument that measures the atmospheric pressure, temperature and relative humidity of the environment;
- a device projecting water and allowing to create a continuous film of water all over the test surface by means of circular full-cone nozzles with the following features: $(120^{0}_{-10})°$ delivery angle and a 2 liter min/m^2 water flow rate;
- an instrument to control the amount of projected water;
- an instrument that measures water temperature;
- instruments that measure displacements;
- a device allowing to fix the measuring instruments and to ensure their stability during the test;
- control and management panel;
- a buyout system of all greatness during the test.

Tests have been followed and recorded in real time with a specific dedicated appliance, producer certified and assembled by Vivotek:

- No 1 webcam PTZ model SD8121 professional with these characteristics:
  - optical objective motorized 12x, automatic focus to allow day/night shooting in low lighting condition until 0,1 Lux/F1.6(color), 0.01 Lux/F1.6(B/W);
  - supports two-way audio via SIP protocol
  - support for combined use of Motion JPEG and MPEG-4;
  - movements PTZ selecting in remote-control by mouse/joystick;
  - resolution of a 720x576 pixel (MPEG-4);
  - level of access multi-user, filter for address IP, HTTPS encrypted data transmission;
  - HTTPPS e authentication IEEE 802.1X for the security of the web.
- Witness Test is locally led and supervised with an embedded real time testing monitoring, physically consisting in a PC with public IP address, UDP or TCP gate, visible external, and FTP server featuring.
- A firewall appliance to manage communication in remote site.

7 Expression of results

7.1 Air permeability (tests A and D, cf. § 4)

Results are expressed in conformity with § 8.4 of standard EN 12153:2000 e and, for the purpose of classification, with § 4 e 6 of standard EN 12152:2002, with reference to EN 1026:2000 and 12207:1999 as far as opening parts are concerned.

At each test pressure, air permeability was determined for the fixed part (Q_f) and for opening joints (Q_j) and expressed in cubic meters/hour, in fulfilment of the relations:

fixed part: $Q_f = Q_{fc} - Q_c$ opening part: $Q_j = Q_{tc} - Q_{fc}$

where Q_c is the leak air in the test chamber, without the effect of the sample which is a known value obtained from previous tests, Q_{fc} is the leak air in the test chamber measured with the opening joints sealed, Q_{tc} is the leak air in the test chamber, measured with the opening joints unsealed.

The subsequent determinations concerned the total area of the sample (A) and the length of opening joints (L_0) and fixed joints (L_f). Finally, the air permeability per unit area of fixed glazing units (Q_f/A) and per unit length of the fixed joint (Q_f/L_f) were calculated and expressed in m^3/m^2h and in m^3/mh respectively and graphically represented at the different test pressures, with correction of the obtained values (V_x) on the basis of the actual values of temperature T_x (expressed in °C) and atmospheric pressure (expressed in kPa), in order to obtain the leak air (V_0) under normal conditions (with T_0 = 293 K and P_0 = 101.3 kPa) using the formula:

$$V_0 = V_x \times \frac{293}{273 + T_x} \times \frac{P_x}{101,3}$$

7.1.1 Classification of the whole curtain wall

In accordance with § 4 and 6 of standard EN 12152:2002, the classification of the received and tested sample considered as a whole, required the fulfilment of the following criteria:

- the air permeability of the fixed areas of the facade does not take into account the passage of air through the opening joints and is related to the positive pressures applied to the total area or to the length of the fixed joints of the sample, while the air permeability of the individual opening parts incorporated into the curtain wall was evaluated with reference to EN 12207:1999;
- performance requirements are established according to Table 1or table 2; as for intermediate air pressures (P_n) air permeability admitted at intermediate air pressures (Q_n) was determined, with Q_0 admitted air permeability at maximum test pressure P_0, using the formula:

$$Q_n = Q_0 \times \left(\frac{P_n}{P_0}\right)^{2/3}$$

- on the basis of test results, the curtain wall sample was assigned the relevant class when the obtained air permeability value did not exceed the upper limit fixed for that class at all intermediate test pressure levels and for maximum value.

Max. pressure P_{max} (Pa)	Air permeability m^3/m^2h	Class
150	1,5	**A1**
300	1,5	**A2**
450	1,5	**A3**
600	1,5	**A4**
>600	1,5	**AE**
Note: samples allowing the passage of > 1.5 m^3/m^2h of air at pressures < 150 Pa can not be classified; those allowing the passage of < 1.5 m^3/m^2h of air at pressures >600 Pa are classified as E (exceptional).		

Max. pressure P_{max} (Pa)	Air permeability m^3/m^2h	Class
150	0,5	**A1**
300	0,5	**A2**
450	0,5	**A3**
600	0,5	**A4**
>600	0,5	**AE**
Note: samples allowing the passage of > 0.5 m^3/m^2h of air at pressures < 150 Pa can not be classified; those allowing the passage of < 0.5 m^3/m^2h of air at pressures >600 Pa are classified as E (exceptional).		

Table 1 and 2. Left to right: Curtain walls – air permeability classes per unit area of fixed panels and per unit length of the fixed joint

7.1.2 Classification of the opening parts of the curtain wall

In accordance with § 8 of standard EN 1026:2000 and § 4 of standard EN 12207:1999, the classification of the opening parts incorporated into the sample, required the fulfilment of the following criteria:

- the results of the leak air measurements related to opening parts (V_x) were corrected on the basis of the actual values of temperature and atmospheric pressure in order to obtain the leak air (V_0) under normal conditions using the previously expressed formula (cf. § 7.1);
- air permeability was related both to the overall area of the opening (expressed in m^3/m^2h) and to the unit length of the opening joint (expressed in m^3/mh) then graphically represented at each test pressure increment;
- relevant classes were established in accordance with Table 3, on the basis of the 100 Pa reference pressure, where air permeability Q admitted at different test pressures P is determined using the following formula (where Q_{100} is the reference air permeability):

$$Q = Q_{100} \times \left(\frac{P}{100}\right)^{2/3}$$

- on the basis of test results, the curtain wall sample was assigned the relevant class when the obtained air permeability value did not exceed the upper limit fixed for that class at all intermediate test pressure levels up to maximum value as a function of the fulfilment of one of the following relations for the two curves, as reported in the bilogarithmic diagram:
- same class: the sample is classified in that class;
- 2 contiguous classes: the sample is classified in the most favourable class;
- 2 class difference: the sample is classified in the medium class;
- more than 2 class difference: the sample must not be classified.

Class	Maximum test pressure (Pa)	Reference air permeability 100 Pa (m^3/hm^2)	Reference air permeability 100 Pa (m^3/hm)
0	Not subjected to test		
1	150	50	12,50
2	300	27	6,75
3	600	9	2,25
4	600	3	0,75

Table 3. Opening modules inserted in the sample – Air permeability classes per unit area and per unit length of opening joints

7.2 Watertightness under static pressure (tests B and E, cf. § 4)

I Results are expressed in accordance with § 9 of standard EN 12155:2000 and, for the purpose of classification, with § 6 of standard EN 12154:1999 (cf. Table 4).

Class	Pressure (Pa) / duration (min) of pressure intervals
R 4	0/15; 50/5; 100/5; 150/5
R 5	0/15; 50/5; 100/5; 150/5; 200/5; 300/5
R 6	0/15; 50/5; 100/5; 150/5; 200/5; 300/5; 450/5
R 7	0/15; 50/5; 100/5; 150/5; 200/5; 300/5; 450/5; 600/5
RE $_{xxx}$	0/15; 50/5; 100/5; 150/5; 200/5; 300/5; 450/5; 600/5; exceeding 600/5 at 150 Pa intervals of 5 minutes each

Table 4. Classification for watertightness under static pressure of curtain walls

7.3 Resistance to wind load (tests C and F, cf. § 4)

Results are expressed in accordance with § 9 of standard EN 12179:2000.
The values of calculated frontal deflections and of the measurements of frontal displacements and residual deformations were reported as a function of test pressures, comparing data with the maximum admitted values as specified in EN 13116:2001 in order to assess their acceptability.

To satisfy the performance requirements laid down in EN 13116:2001 and, in particular, in accordance with § 4, results must respect the following acceptability criteria:

- the curtain wall must safely transmit the design load via the points of support back to the building structure;
- the curtain wall must be able to withstand the design load without any reduction in the specified performance requirements.

I In particular, at least the following performances under design load conditions must be reached (cf. test C, § 4):

- he frontal deflection, under positive and negative design loads, must not exceed 1/200 of the span of the considered framing member, measured between points of structural support and 15 mm;
- the frontal deflection must be temporary deformation only, and must recover after the removal of load by a minimum of 95% within a time period of 1 h;
- the frontal displacement of fixings of framing members at their connections to the building structure or other structural components must be limited to less than 1 mm and this must be allowed as residual deformation;
- the positive difference between the air permeability measured at maximum pressure in the first and second tests, should not differ by more than 0.3 $m^3/h.m^2$ or 0.1 $m^3/h.m$ length of joint.

In particular, at least the following performances under increased load conditions must be reached (cf. test F, § 4):

- under both positive and negative increased load no permanent damage must occur to framing members, infill panels, opening units, fasteners or anchors;
- panels, glazing beads and decorative capping pieces must remain securely held and gaskets must not be displaced;
- if a pane of glass breaks, then it may be replaced and the test continued only if, following close examination, the cause of breakage is not attributable to any fault in the glazing technique or the supporting frame.

8 Results

8.1 Preventive control on the sample (dimensions and surfaces)

Measures (cf. Fig. 1)	width (m)	height (m)	surface (m^2)	fixed joint lengths (m)
Whole sample	2.516	3.016	**7.588**	**14.080**

Table 5

8.2 Air permeability test (test A, cf. § 4)

DATE OF TEST	LABORATORY ENVIRONMENTAL PARAMETERS		
	Temperature (°C)	Relative humidity (%)	Atmospheric pressure (kPa)
2015-10-30	T_x= 22.1	R.H.= 35.0	P_x= 101.0

Table 6

8.2.1 Test under positive pressure

Positive Pressure	Air permeability of the curtain wall		
Pa	Q_f m^3/h	Q_f/A $m^3/h.m^2$	Q_f/L_f $m^3/h\ m$
50	0.21	0.03	0.01
100	0.63	0.08	0.04
150	0.76	0.10	0.05
200	0.76	0.10	0.05
250	0.86	0.11	0.06
300	0.97	0.13	0.07
450	1.33	0.17	0.09
600	1.80	0.24	0.13

Table 7

Q_f = air permeability of fixed part;
Q_f/A = air permeability per unit area of fixed panels;
Q_f/L_f = air permeability per unit length of the fixed joint

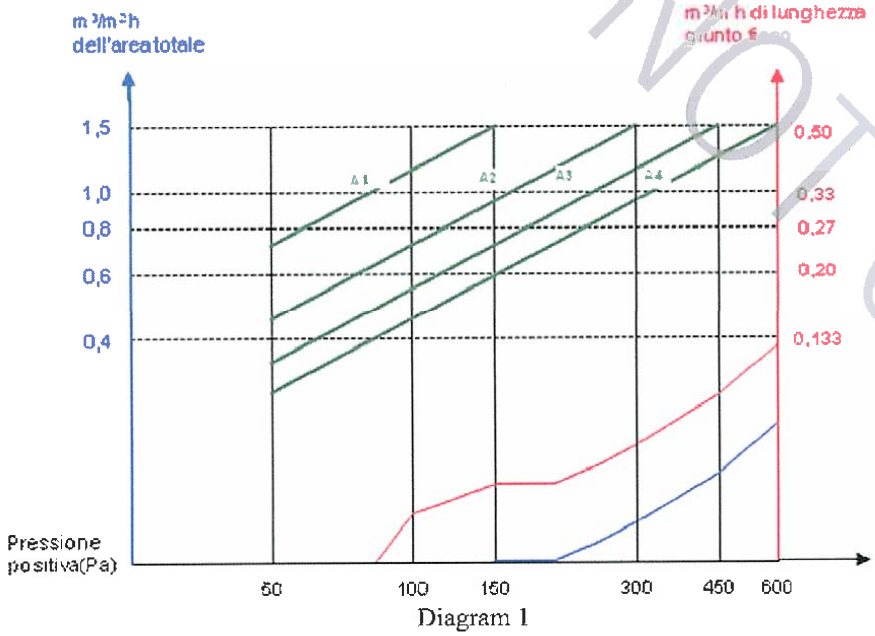


Diagram 1

8.2.1.1 Classification of the sample (curtain wall)

The sample subjected to air permeability test under positive pressure was classified in class **A4**.

8.2.2 Test under negative pressure

Negative pressure	Air permeability of the curtain wall		
Pa	Q_f	Q_f/A	Q_f/L_f
	m^3/h	$m^3/h.m^2$	$m^3/h\ m$
50	0.36	0.05	0.03
100	0.89	0.12	0.06
150	0.88	0.12	0.06
200	1.09	0.14	0.08
250	1.24	0.16	0.09
300	1.44	0.19	0.10
450	1.74	0.23	0.12
600	2.17	0.29	0.15

Table 8

Q_f = air permeability of fixed part;
Q_f/A = air permeability per unit area of fixed panels;
Q_f/L_f = air permeability per unit length of the fixed joint

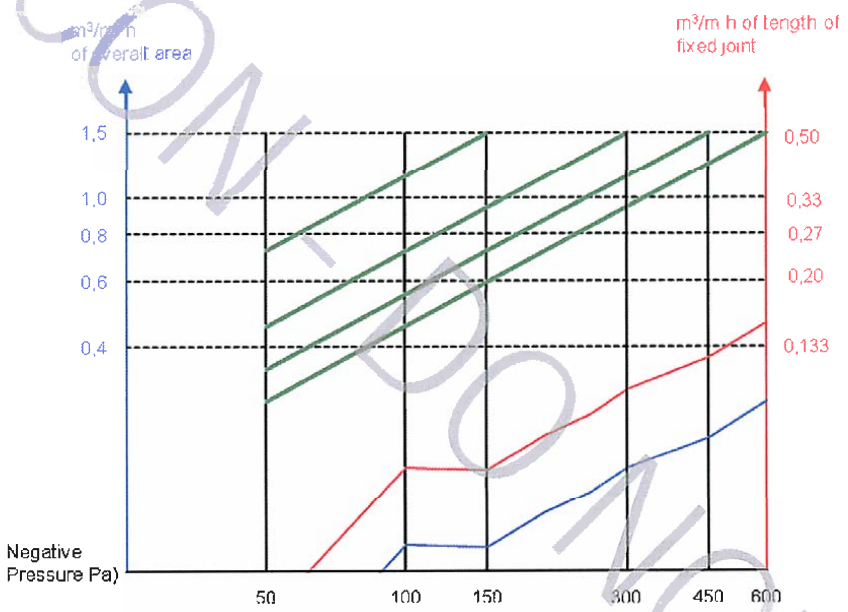


Diagram 2

8.2.2.1 Classification of the sample (curtain wall)
The sample subjected to air permeability test under negative pressure was classified in class **A4.**

8.3 Watertightness under static pressure (test B, cf. § 4)

DATE OF TEST	LABORATORY ENVIRONMENTAL PARAMETERS		
	Temperature (°C)	Relative humidity (%)	Water temperature (°C)
2015-10-30	T_x= 22.3	H.R.= 35.0	T_w = 10.5

Table 9

Pressure (Pa)	Duration (min)	Remarks
0	15	No water seepage
50	5	
100		
150		
200		
250		
300		
450		
600		
750		
900		
1050		
1200		
1350		
1500		

Table 10

8.3.1 Classification of the sample

The sample subjected to watertightness test under static pressure was classified in class **RE1500**.

8.4 Resistance to wind load test under design load conditions (test C, cf. § 4)

DATE OF TEST	LABORATORY ENVIRONMENTAL PARAMETERS		
	Temperature (°C)	Relative humidity (%)	Atmospheric pressure (kPa)
2015-10-30	T_x= 23.8	H.R.= 35.0	P_x= 101.0

Table 11

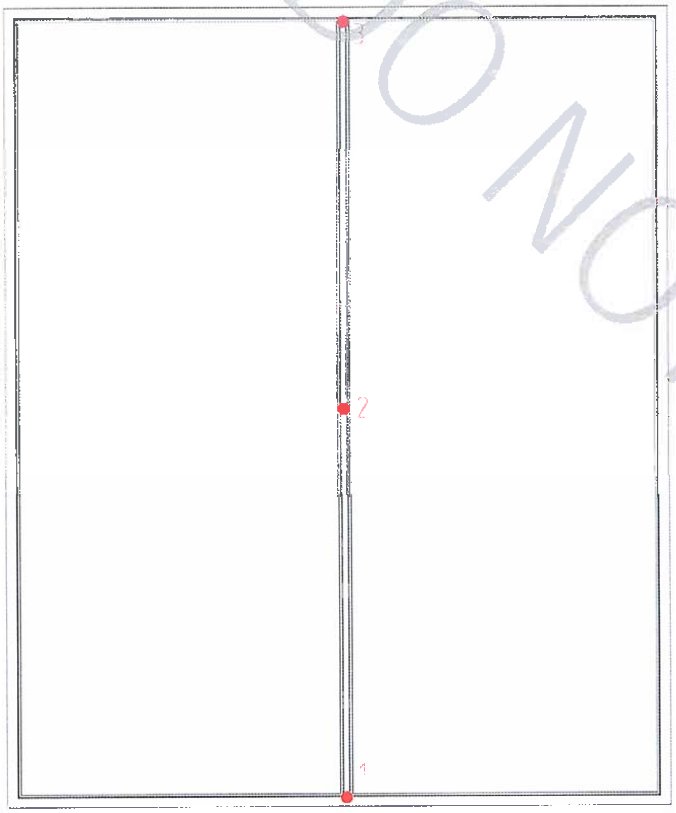


Fig. 41. Experimental set-up of the resistance to wind load test: transducers positioning scheme - Elevation inside view

Elements Span	mullion	2715 mm
Declared design wind load		± 1600 Pa

Table 12

Positive pressure (Pa)	**p. 1 (mm)**	**p. 2 (mm)**	**p. 3 (mm)**
400	0.15	0.34	0.07
800	0.34	0.88	0.18
1200	0.54	1.50	0.30
1600	0.19	2.14	0.44
0	0.02	0.03	0.05
Negative pressure (Pa)	**p. 1 (mm)**	**p. 2 (mm)**	**p. 3 (mm)**
400	0.19	0.50	0.11
800	0.40	1.10	0.24
1200	0.62	1.74	0.39
1600	0.84	2.39	0.54
0	0.02	0.02	0.01

Table 13. Frontal displacements of measured characteristic points at different test pressure steps (cf. Fig. 41)

Mullion	Positive pressure (Pa)	Frontal displacements (mm)			Frontal deflection (mm)	Relative frontal deflection
		p.1 (top)	p.2 (centre)	p.3 (bottom)		
	1600	0.19	2.14	0.44	1.83	**1/1488**
		Residual deformations within 1 h (mm)			Frontal deflection within 1 h (mm)	
	0	0.02	0.03	0.05	0.01	
	Negative pressure (Pa)	Frontal displacements (mm)			Frontal deflection (mm)	Relative frontal deflection
		p.1 (top)	p.2 (centre)	p.3 (bottom)		
	1600	0.84	2.39	0.54	1.70	**1/1597**
		Residual deformations within 1 h (mm)			Frontal deflection within 1 h (mm)	
	0	0.02	0.02	0.01	0.01	

Table 14. Relative frontal deflections and residual deformations within 1 h of mullion of the sample tested under positive and negative design load conditions (internal observation)

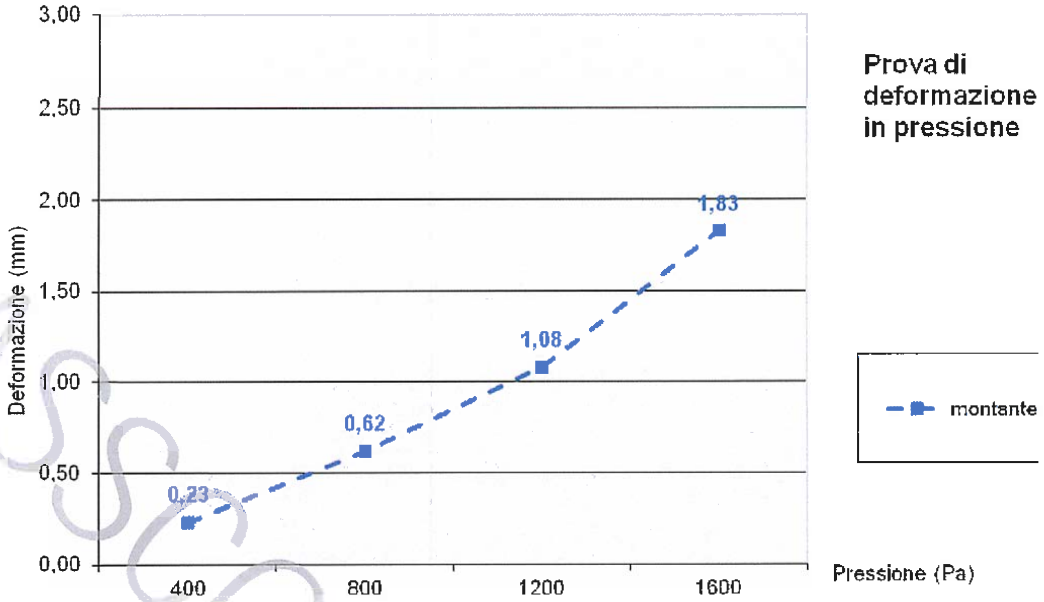


Table 15. Frontal deflections of mullion under positive pressure, under test pressures

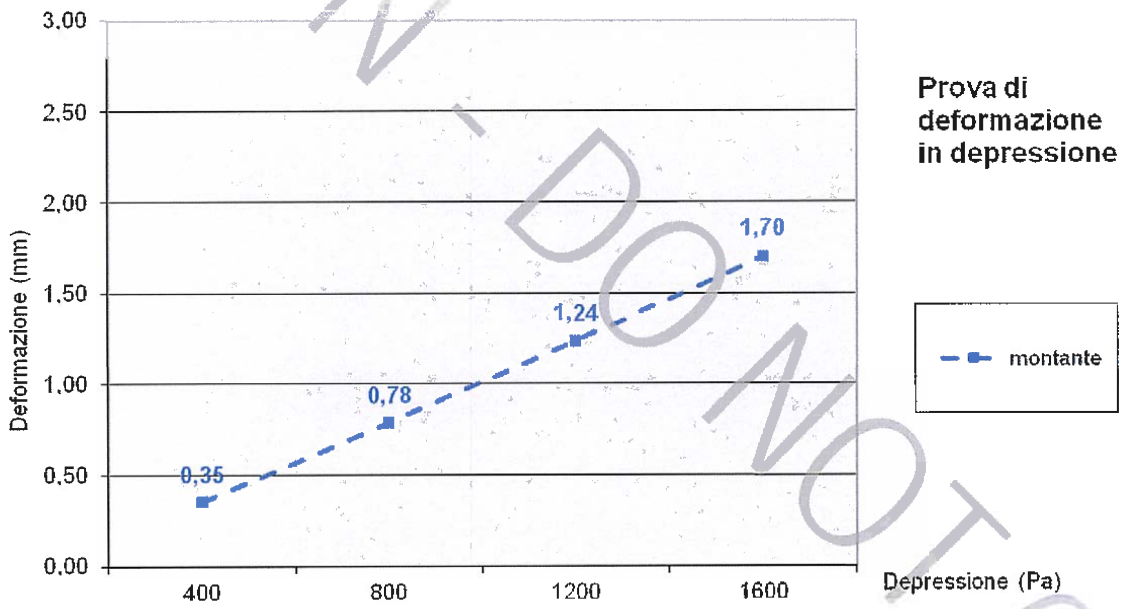


Table 16. Frontal deflections of mullion under negative pressure, under test pressures

8.4.1 Remarks on results

- In conformity with the performance requirements laid down at § 4 of standard EN 13116:2001, the frontal deflections of the tested sample recorded under positive and negative design load conditions result to be less than the smaller measure between 1/200 of the span of the considered framing member and 15 mm. For the specific tested curtain walling, the limit results to be, for mullion at 15 mm, lower than 1/200 of the relative width (equivalent to 13.57 mm).
- In conformity with the requirements laid down at § 4 of standard EN 13116:2001, the recorded frontal deflections resulted to be temporary and recovered by a minimum of 95% within the allowed time period of 1 h.

8.5 Air permeability test (test D, cf. § 4)

DATE OF TEST	LABORATORY ENVIRONMENTAL PARAMETERS		
	Temperature (°C)	Relative humidity (%)	Atmospheric pressure (kPa)
2015-10-30	T_x= 24.1	H.R.= 35.0	P_x= 101.0

Table 17

8.5.1 Test under positive pressure

Positive pressure	Air permeability of the curtain wall		
Pa	Q_f m^3/h	Q_f/A $m^3/h.m^2$	Q_f/L_f $m^3/h\ m$
50	0,76	0,10	0,05
100	1,13	0,15	0,08
150	1,56	0,21	0,11
200	2,02	0,27	0,14
250	2,39	0,31	0,17
300	2,72	0,36	0,19
450	3,73	0,49	0,26
600	4,42	0,58	0,31

Table 18

Q_f = air permeability of fixed part;
Q_f/A = air permeability per unit area of fixed panels;
Q_f/L_f – air permeability per unit length of the fixed joint

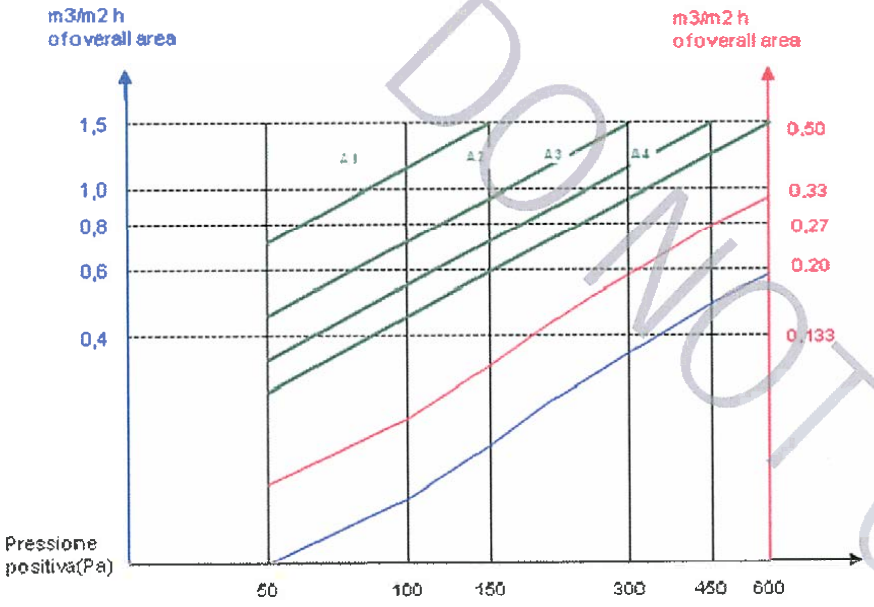


Diagram 3

8.5.2 Test under negative pressure

Negative pressure	Air permeability of the curtain wall		
Pa	Q_f	Q_f/A	Q_f/L_f
	m^3/h	$m^3/h.m^2$	$m^3/h\ m$
50	0.66	0.09	0.05
100	1.31	0.17	0.09
150	1.16	0.15	0.08
200	1.65	0.22	0.12
250	1.87	0.25	0.13
300	2.07	0.27	0.15
450	2.84	0.37	0.20
600	3.27	0.43	0.23

Table 19

Q_f = air permeability of fixed part
Q_f/A = air permeability per unit area of fixed panels
Q_f/L_f = air permeability per unit length of the fixed joint

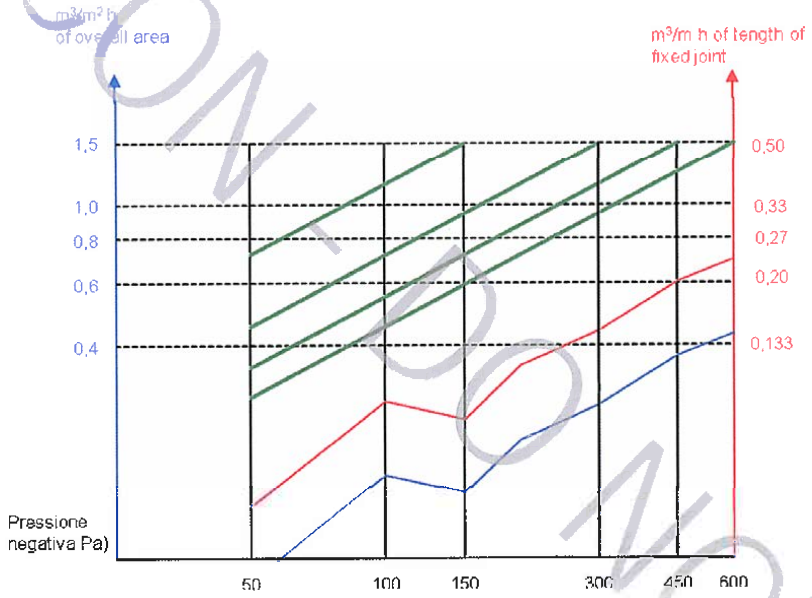


Diagram 4

8.5.3 Remarks on obtained results

In conformity with the performance requirements laid down at § 4 of standard EN 13116:2001, the positive difference between the air permeability of the sample (curtain wall) measured at maximum pressure in the first and second tests respectively, resulted to fall within the envisaged limits (0.3 m^3/hm^2 or 0.1 m^3/hm) both under positive and negative pressure.

8.6 Watertightness test (test E, cf. § 4)

DATE OF TEST	LABORATORY ENVIRONMENTAL PARAMETERS		
	Temperature (°C)	Relative humidity (%)	Water temperature (°C)
2015-10-30	T_x= 24.5	H.R.= 35.0	T_w = 10.8

Table 20

Pressure (Pa)	Duration (min)	Remarks
0	15	No water seepage
50	5	
100		
150		
200		
250		
300		
450		
600		
750		
900		
1050		
1200		
1350		
1500		

Table 21

8.6.1 Remarks on obtained results

The watertightness classification obtained previously was confirmed.

8.7 Resistance to wind load test under increased load conditions - safety conditions (test F, cf. § 4)

	Observed structural damages or degradations
n° 1 gust at + 2400 Pa	none
n° 1 gust at – 2400 Pa	none

Table 22

8.7.1 Remarks on obtained results:

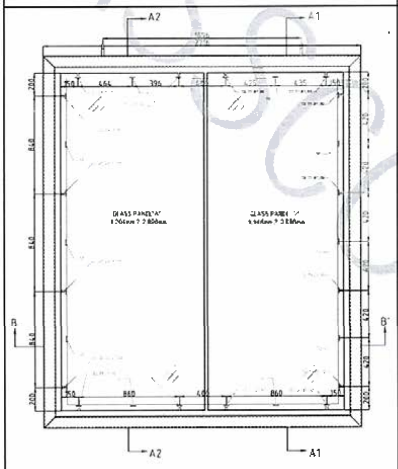
- In conformity with the performance requirements laid down at § 4 of standard EN 13116:2001, at the end of the test performed under both positive and negative increased load, no permanent damage occurred to elements and members making up the sample under test.
- In conformity with the performance requirements laid down at § 4 of standard EN 13116:2001, at the end of the test performed under both positive and negative increased load, the elements making up the sample under test (panels, glazing beads and decorative capping pieces) remained securely held and gaskets remained in their place.

8 Photographs of the sample under test and of the experimental setup

Photo 1. Tested sample in the experimental setup

Photo 2. Tested sample undergoing watertightness test

10 Resume of classes assigned on the basis of the results of the tested sample of "GLASSCON/ SNFCC – RENZO PIANO FT-03", with trade name given by the applicant "GLASSCON GmbH", according to TR No 1994-CPR-RP1304, issued on 2016-02-08 to GLASSCON S.A., to which fully refer.

Scheme of the tested sample	Test	Test standard	Classification standard / requirements	Obtained Class (sequence § 5.2.3 EN 13830:2003)	C.f. § TR
 3016 (H) x 2516(W) mm	Air permeability	EN 12153:2000	EN 12152:2002	Positive pressure: class A4	§ 8.2.1.1
				Negative pressure: class A4	§ 8.2.2.1
	Watertightness	EN 12155:2000	EN 12154:1999	class RE 1500	§ 8.3.1
	Resistance to wind load	EN 12179:2000	EN 13116:2001	Design load: 1600Pa Increased load: 2400Pa	from §8.4 to §8.7.1

11 Limitations

This Test Report does not represent either an evaluation the suitability of use or a certificate of product conformity. The results obtained refer exclusively to the samples tested.

Technical Operator
Katia Foti
Matteo Mariotto

Technical Director
Giovanni Cavanna

----------End of the Test Report No. 1994-CPR-RP1304----------